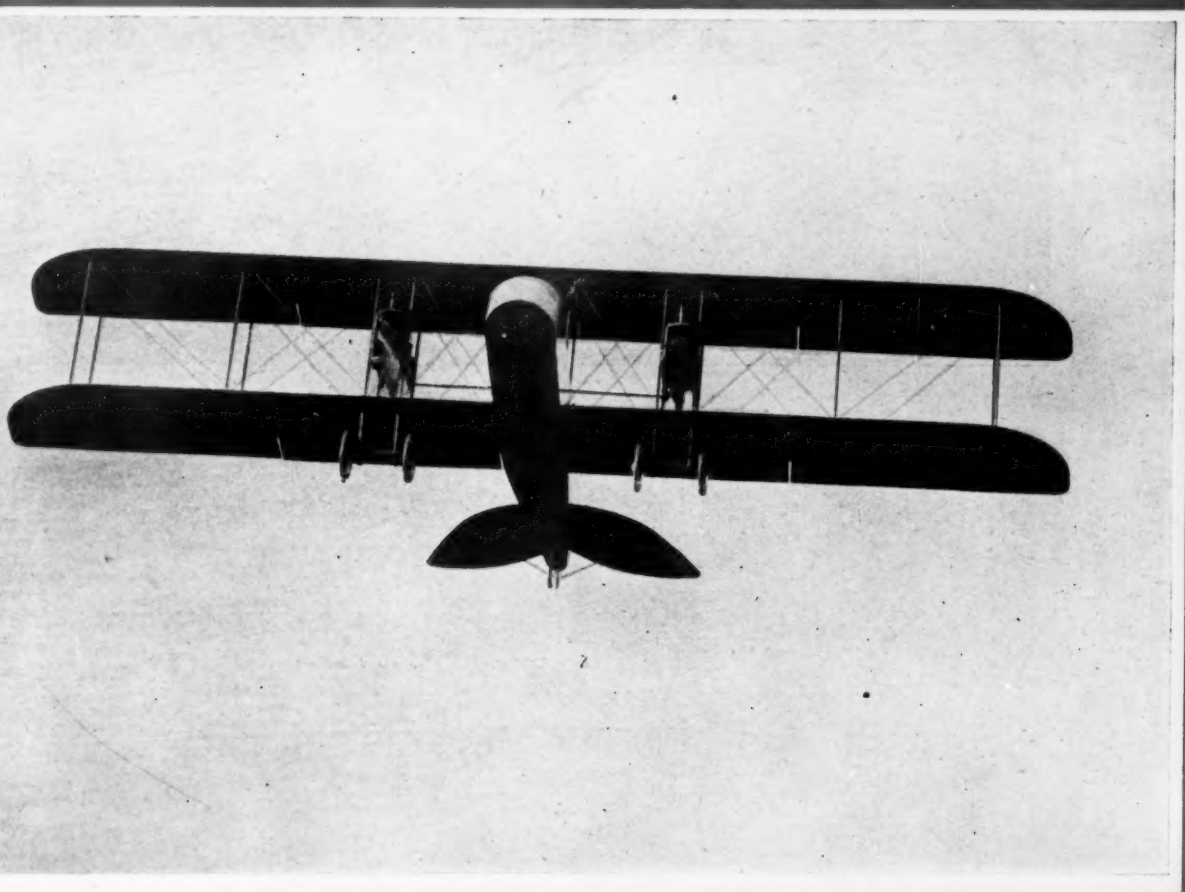
AVIATION AND AERONAUTICAL ENGINEERING



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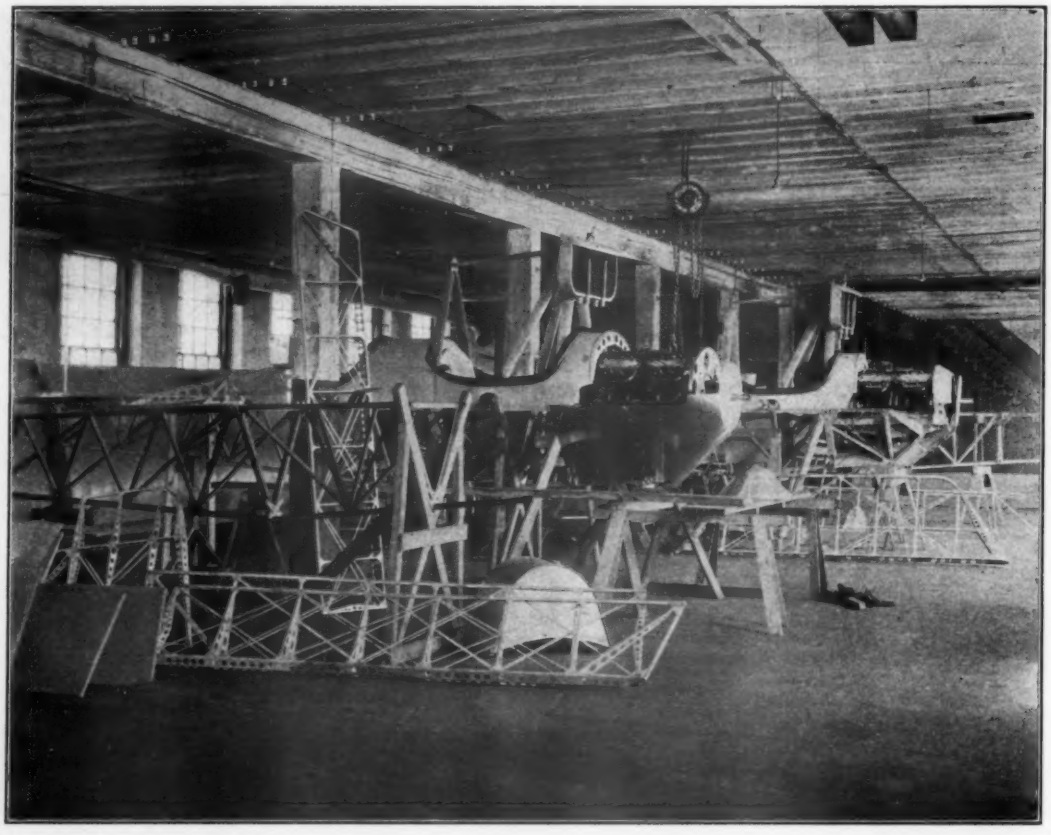

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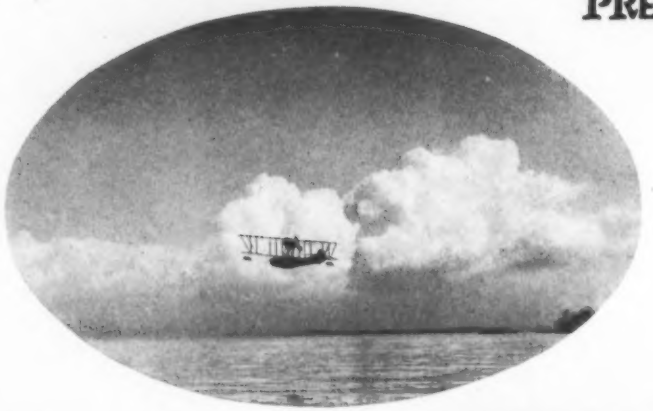

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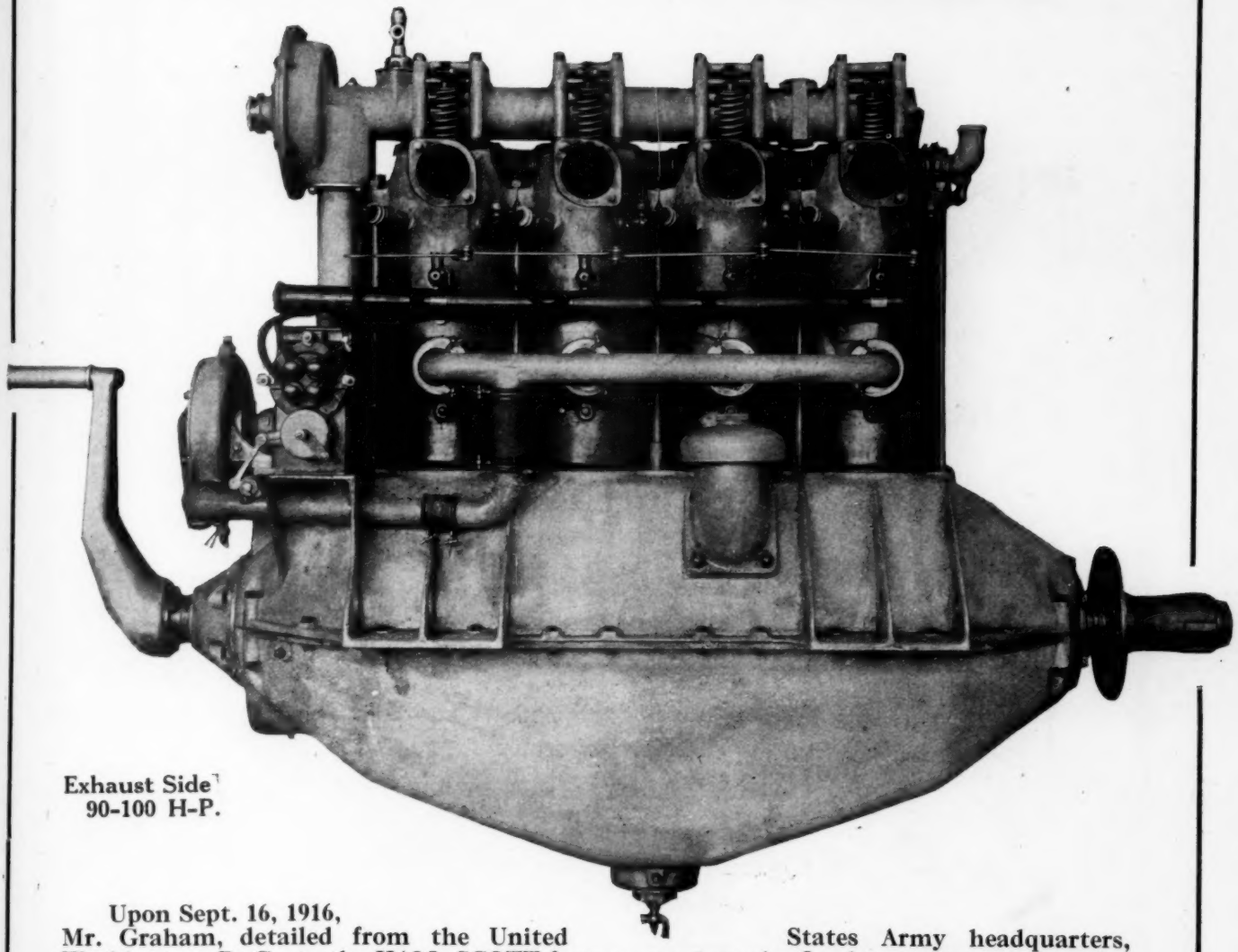

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OCTOBER 1, 1916

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. I. NO. 5

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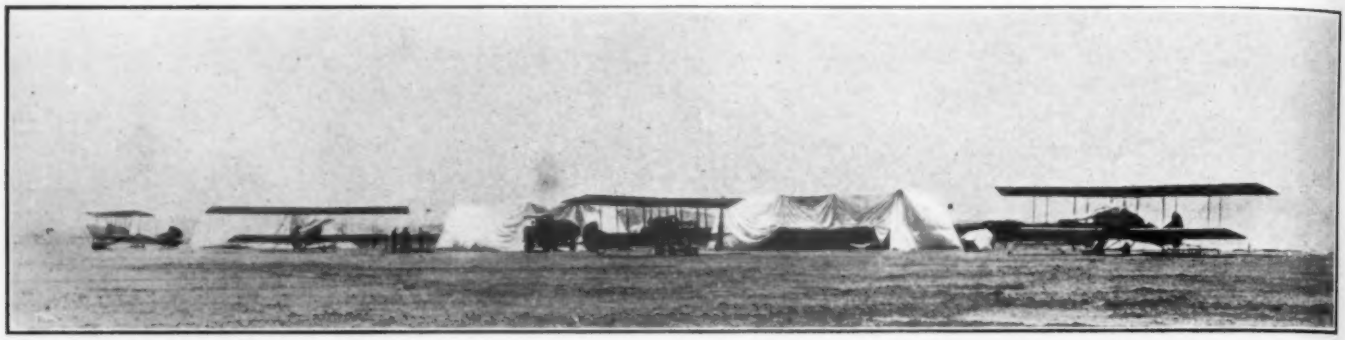
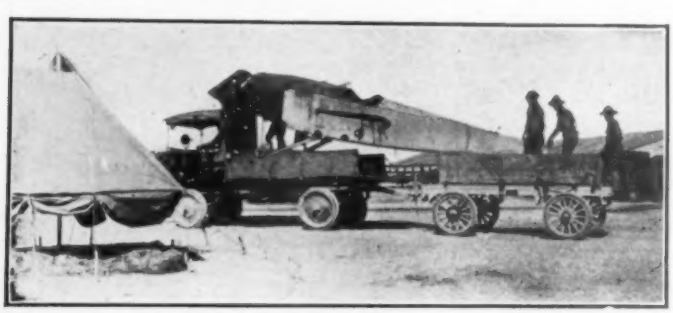
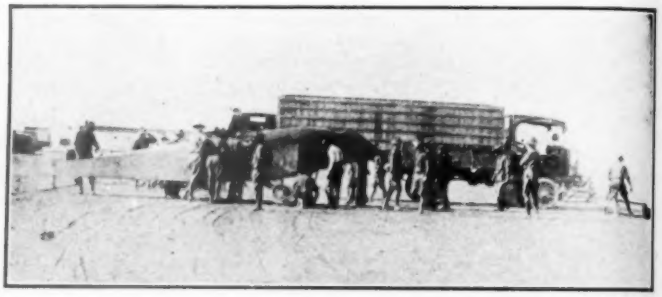
The First Aero Squadron U. S. A. on the Border



Four of the twelve 160 horsepower tractor biplanes, with their tent-hangars, on the border near Columbus, N. M.





Two views of the Curtiss 200 horsepower twin tractor, belonging to the National Guard of New Mexico, arriving at the aviation camp on the border. The manner of transportation by automobile truck and trailer is interesting.

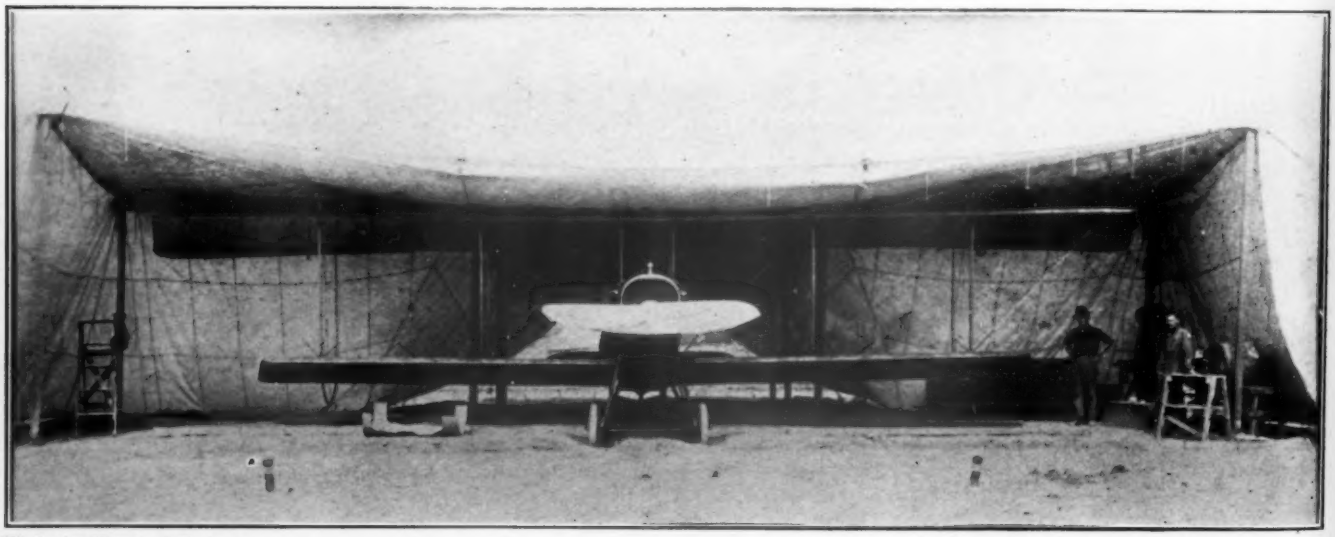


Photo by Harris & Ewing.

A tent-hangar housing an aeroplane at Columbus, N. M. This photograph illustrates the method of covering propellers which was in use in June. At the present time propellers, when not in use, are removed from their mountings and stored in humidors, where they can be kept damp.

Housing and Transporting War Machines

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Vol. 1 | October 1, 1916 | No. 5

THE list of 817 aviators sent to us for publication by the War Department, which may be found on another page of this issue of AVIATION AND AERONAUTICAL ENGINEERING, is significant. It was transmitted to us with a request that we give it the widest publicity possible, in order that the War Department may secure the address of every man who may be available for service with the Flying Corps. The fact that the Aviation Section has sent out this list, shows that it is doing everything in its power to try to secure aviators for the United States Army; it shows that the files of the Aviation Section in Washington contain much information on the subject of civilian aviators; it is indicative of the earnest efforts that the Section is making, to lose no time in supplying the United States with a real aerial reserve.

Another significant feature of the list is to be found in the fact that about fifty per cent. of those whose names appear on it, have never taken certificates as pilots. It shows that there are many aviators who are flying or have flown who have not thought it necessary to obtain the Federation Aéronautique Internationale certificate. With eight hundred experienced pilots to choose from, the Aviation Section should in a short time have in training a body of patriotic reservists who could render invaluable assistance in time of need.

AVIATION AND AERONAUTICAL ENGINEERING will be glad to transmit to the War Department the names and addresses of any other aviators besides the ones on the list, if they will forward their names to us with their addresses and the other information asked for in Lieut.-Col. Squier's letter with which he transmitted the list to us.

Zeppelin Activities

The recent Zeppelin raids on England are attracting the attention of all aeronautical engineers to dirigible balloons, both of the rigid and non-rigid types.

On Sunday, September 3, Lieutenant William Leefe Robinson, R. F. C., brought down an airship at Enfield, about ten miles from London. Lieutenant Robinson was in the air two hours manoeuvring against the dirigible, before he was able to strike the blow which caused it to fall to earth in flames.

Owing to the meagre information that has reached this country, and to the fact that a very large proportion of the ship was destroyed by the heat of the burning gases and the final impact when it struck the ground, it has not been positively established what particular type this machine represented. English aeronautical journals are unanimous in the declaration it was a Schütte-Lanz, probably an old one, which would indicate it to have been about a fourth-rate airship. It is a well established fact that the characteristic Zeppelin aeroplane has its gas bag braced by box-girder construction of aluminum alloy. Judging from the photographs which appeared in this country, this form of construction was not used in the airship brought down at Enfield; on the contrary, the chief peculiarity of the mass of wreckage is to be found in the quantities of wire bracing. There is said to have been enough wire to fill completely thirty-six motor lorries. The wire bracing probably shows that the bracing of the airship's gas bag was of wood. Wood construction would be an indication that the craft was probably a Schütte-Lanz, which is well known to be built with a trellis-like wooden framework. The motors, from the vague descriptions and indistinct photographs that have appeared in this country, were of the six-cylinder upright vertical type. The characteristic Mercedes overhead valve gear appears to be lacking. It is possible that they may have been 180 horse power Maybach engines.

The airship was fitted with four motors, and if the surmise that they were 180 horse power Maybachs is correct, the machine had a total of 720 horse power. Each engine was fitted with a demultiplication gear-box and propeller shaft in line with the engine, showing that the gondolas each had a propeller at their stream-lined sterns instead of bevel-driven cross shafts to propellers at the side of the airship as in the Zeppelins. The airship was of stream line form.

The damage done in the recent aerial raids made on England have been quite extensive, although its military value is an open question. There is no question, however, that Zeppelins possess a certain military value. This was best illustrated perhaps, in the Jutland naval battle, where the German admiral had the advantage of dirigibles, first, in spotting his shots and correcting the range finders of the men in the fighting tops, and later in warning him of the approach of the British Grand Fleet, which, it will be remembered, did not arrive until after Admiral Beatty's battle cruiser squadron had been engaged for some hours.

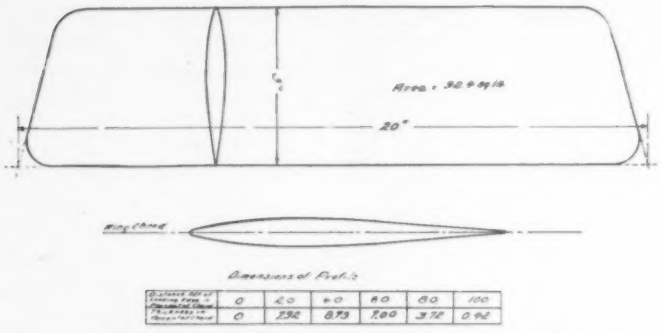
Those who are best fitted to comprehend the progress that Germany has made since the start of the war, state that a single trans-Atlantic voyage would present few difficulties to one of Germany's modern dirigibles. Nevertheless, if a Zeppelin should come to this country, it would be an important achievement.

Aeroplane Control Surfaces

By J. C. Hunsaker, Eng.D.
and
T. H. Huff, S.B.

Object of Investigation

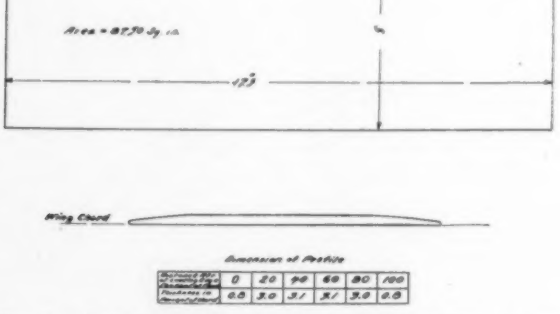
With the recent great increase in size of aeroplanes, it has become increasingly difficult to provide control surfaces (ailerons, elevators, rudders) of adequate strength and stiffness without the use of elaborate exterior bracing, adding to head resistance and the number of parts whose failure may be disastrous. Very large control surfaces, if hand operated, require an effort beyond the muscular strength of the pilot unless the control mechanism be geared down at the expense of



	0	2.0	4.0	8.0	6.0	10.0
	0	2.92	8.73	7.00	3.72	0.92

FIG. 1. DOUBLE CAMBERED ELEVATOR SURFACE AS TESTED AT THE M. I. T. AERODYNAMICAL LABORATORY

celerity of movement. The standard method of fitting trailing ailerons and elevator flaps renders "balancing," as usually employed on rudders, an impracticable means of relief. It would be of advantage to have a control surface which could be given great thickness (to provide structural strength) without material sacrifice in the aerodynamical properties of the usual thin, nearly flat, control surface. The center of pressure motion must be such that the surface may safely be "balanced."



	0	2.0	4.0	6.0	8.0	10.0
	0.0	3.0	3.1	3.1	3.0	0.0

FIG. 2. SAINT CYR SURFACE NO. 1 AS TESTED AT THE NATIONAL PHYSICAL LABORATORY

Profiles Discussed

The Curtiss Aeroplane Company have proposed a double cambered surface of great thickness, Fig. 1. A model 20 by 5 inches of this surface was sent by this company to be tested in the wind tunnel of the Massachusetts Institute of Technology and the results are now published with their permission. It will be seen that the maximum thickness of this profile is nearly 9 per cent of the chord; about double usual practice. Ample space is afforded thus for substantial ribs and spars.

To compare with this profile, we have selected the thin flat surface of Fig. 2, which has been tested full size at St. Cyr[1] and in the wind tunnels at Auteuil[2] and at Teddington.[3] Without discussion of the discrepancies between the three sets of experiments, we will reproduce the results obtained at Teddington on a model of nearly the same size as our Curtiss profile, tested at nearly the same wind velocity and with a wind tunnel and balance identical with our own. Under these conditions the results for the two profiles are comparable, and possible errors of method being common to both sets of experiments may be ignored for purposes of comparison.

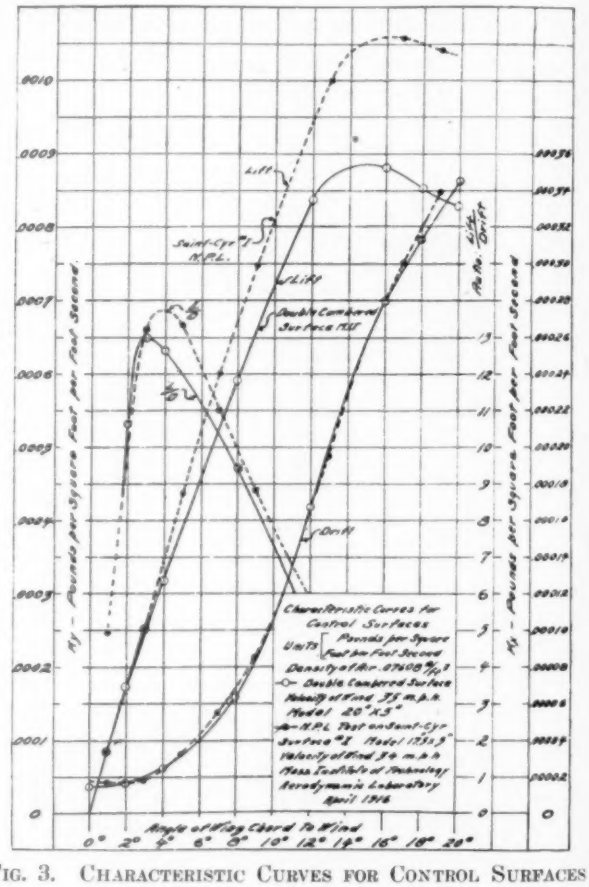

Lift
Drift
Double Cambered Surface No. XIII
Characteristic Curves for Control Surfaces
Units Pounds per Square Foot per Foot Second
Density of Air .07506 lb./cu. ft.
Double Cambered Surface
Velocity of Wind 35 m.p.h.
Model 20" x 5"
N.P.L. Test on Saint-Cyr Surface "1" Model 17.5 x 5"
Velocity of Wind 34 m.p.h.
Mass. Institute of Technology Aerodynamic Laboratory April 1914
Angle of Wing Chord To Wind
0° 2° 4° 6° 8° 10° 12° 14° 16° 18° 20°

FIG. 3. CHARACTERISTIC CURVES FOR CONTROL SURFACES

It will be noted that the St. Cyr profile is only one-third as thick as the Curtiss and is unsymmetrical, giving the effect of camber on one side only. In general, a control surface is to be operated on either side of its neutral position and ought to give equal effects for positive and negative angles. It should, therefore, be symmetrical. It might be suggested that we should compare with well known data for flat plates with square edges. There, however, the edges are so blunt that the resistance at small angles of incidence is excessive. Also such profiles are not used on modern aeroplanes.

Aerodynamical Properties

For the Curtiss profile the angle of zero lift is 0°. In Fig. 3 the curves of the aerodynamical coefficients, lift and resistance (drag), for the double cambered profile are plotted on angle of median line to wind as abscissae. The correspond-

[1] "Bulletin de l'Institut Aérotechnique de l'Université de Paris," vol. ii, Paris, 1912.
[2] G. Eiffel. "La Resistance de l'Air et Aviation," p. 357, Paris, 1914.
[3] Technical Report of the Advisory Committee for Aeronautics, Year 1912-13, p. 79, London, 1914

ing curves as reported for the St. Cyr profile have been shifted 1° to the right in order to make the curves of lift coefficient pass through 0°. Due to lack of symmetry the lift on the St. Cyr surface is zero when the lower chord makes an angle of —1° with the wind. (See N. P. L. test.)

The curves of resistance coefficient are nearly identical for the two wings and for small angles the lift coefficients are not greatly different. At large angles, the St. Cyr profile shows from 10 to 20 per cent greater lift than we get for the Curtiss. On the other hand, if the plot were extended to negative

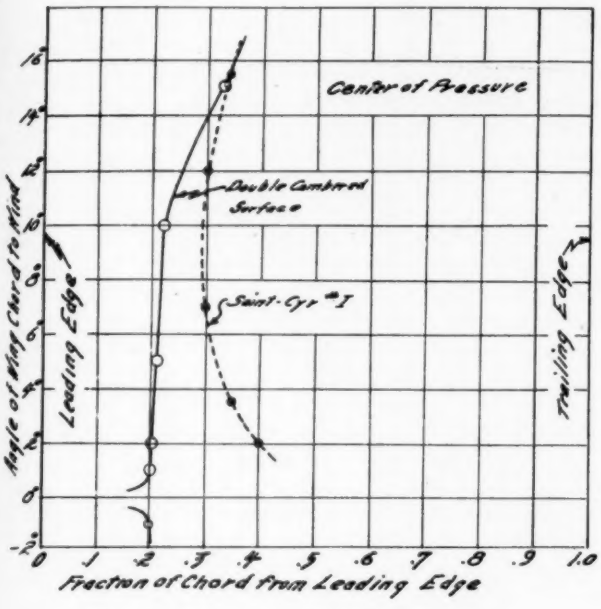


FIG. 4. CENTER OF PRESSURE DIAGRAM

angles, the lift of the Curtiss profile would be equal and opposite while the lift of the other would be reduced due to its virtual camber being useless at negative angles. The greater lift at large positive angles for the St. Cyr profile is not in general a real advantage.

The maximum lift for each profile is reached at about 16°. which angle should be the maximum control movement allowed the pilot in the design. The ratio, to resistance, is about 13 for the two profiles at an angle between 3° and 4°.

The greatest interest attaches to the minimum resistance and the resistance at very small angles for, ordinarily, the aeroplane in good weather will be flown with its control surfaces very near the neutral position. Excessive resistance at the neutral position (angle of no lift) is a waste of power. The curves of Fig. 3 show that the thick Curtiss profile has no more resistance than the other.

In conclusion, it appears that the extra thickness required for rigidity is obtained in the Curtiss profile without material sacrifice in aerodynamical properties.

Center of Pressure

The location of the center of pressure for the two profiles is shown on Fig. 4. The Curtiss profile with hinge axis .2 of chord from leading edge would be almost perfectly "balanced" and a pilot could move it 10° or more without sensible effort. If control were abandoned, the surface would automatically return to a neutral position. Similarly, the St. Cyr profile with axis near .28 of the chord from the leading edge could be used for a "balanced" control surface.

Variation with Speed of Test

Opportunity was taken to repeat the test on the Curtiss profile at 15, 25 and 35 miles per hour. The results plotted as a polar diagram (after Eiffel) are shown on Fig. 5. The discrepancies are not great. At small angles or for values of the lift coefficient below $K_y = .0003$, the resistance, coefficient K_x is progressively diminishing as the speed is raised. This is undoubtedly due to the fact that at such small angles of incidences the resistance is largely skin friction which does not vary so rapidly as the square of the speed.

For values of K_y above .0008, we approach the "burble" point or critical angle for the wing. Here the flow is turbulent and measurement difficult. It is possible that the wind of the tunnel may have a certain degree of turbulence which is more pronounced at some speeds than at others. The turbulence of the wind should have its greatest effect upon the lift of an aeroplane wing near the critical angle. The discrepancy between the curves near the critical angle is of the order of 5 per cent and is probably inherent in wind tunnel experiments. We recommend that an average value be taken in this region.

The very low resistance shown for the double cambered wing

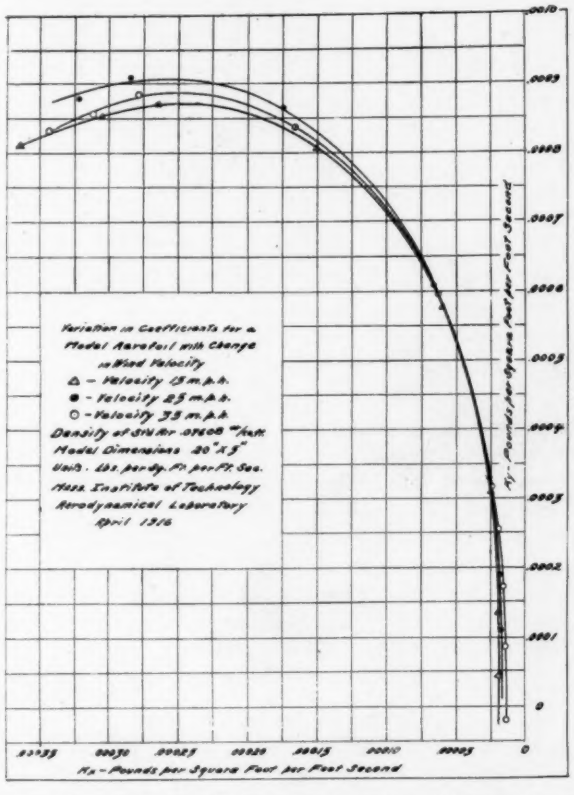

Variation in Coefficients for a Model Aerofoil with Change in Wind Velocity
Δ – Velocity 15 m.p.h.
● – Velocity 25 m.p.h.
○ – Velocity 35 m.p.h.
Density of Air .07608 "Duff"
Model Dimensions 20"x5"
Units. Lbs. per sq. Ft. per Ft. Sec.
Mass. Institute of Technology
Aerodynamical Laboratory
April 1916
Ky – Pounds per Square Foot per Foot Second
Kx – Pounds per Square Foot per Foot Second

FIG. 5. VARIATION IN COEFFICIENTS FOR A MODEL AEROFOIL WITH CHANGE IN WIND VELOCITY

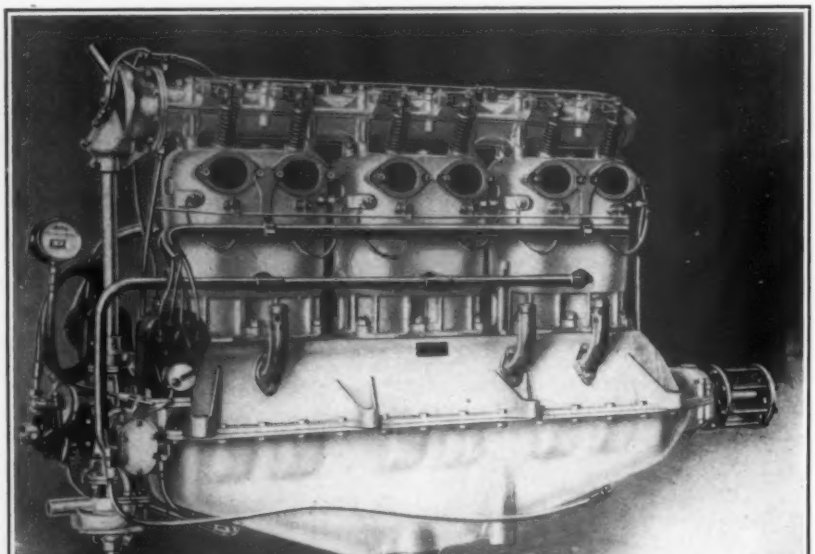
at small angles is probably materially less for full size surfaces moving at speeds of 70 to 100 miles per hour. Similar model tests on a wing of profile R. A. F. 6 give a minimum $K_x = .0000375$ against $K_y = .000015$ for the double cambered surface. The latter has less than one-half the resistance of the former. For a racing aeroplane or speed scout which could tolerate a very high landing speed, it might be possibly of advantage to use the double cambered profile for the wings as well as for the controls.

Output of Aircraft Under Pressure of War

Brig.-Gen. F. G. Stone in *Engineering* urges that experimental work should be carried out under conditions that will test the practicability of quantity output and that in order to secure this, the initial contracts should be let for a lot of a least fifty machines, all to be built in the same shop. The large figure no doubt readily applies to present British conditions.

Wisconsin Aviation Engines

The new six cylinder Wisconsin aviation engines, of which dimensioned drawings and other details are now at hand, are of the vertical type with cylinders in pairs and valves in the head. The cylinders are made of aluminum alloy castings, are bored and machined and then fitted with hardened steel sleeves about 1/16 inch in thickness. After these sleeves have been shrunk into the cylinders, they are finished by grinding in place. Gray iron valve seats are cast into the cylinders. The valve seats and cylinders, as well as the valve ports, are entirely surrounded by water jackets. The valves set in the heads at an angle of 25° from the vertical, are made of rich tungsten steel and are provided with double springs, the outer or main spring and the inner or auxiliary spring, which is used as a precautionary measure to prevent a valve falling into the cylinder in remote case of a main spring breaking.



THE WISCONSIN SIX-CYLINDER AVIATION ENGINE.

CAM SHAFT

The cam shaft is made of one solid forging, case hardened. It is carried in an aluminum housing bolted to the top of the cylinders. This housing is split horizontally, the upper half carrying the chrome vanadium steel rocker levers. The lower half has an oil return trough cast integral, into which the excess oil overflows and then drains back to the crank case. Small inspection plates are fitted over the cams and inner ends of the cam rocker levers. The cam shaft runs in bronze bearings and the drive is through vertical shaft and bevel gears.

CRANK CASE

The crank case is made of aluminum, the upper half carrying the bearings for the crank shaft. The lower half carries the oil sump in which all of the oil except that circulating through the system at the time is carried.

CRANK SHAFT AND BEARINGS

The crank shaft is made of chrome vanadium steel of an elastic limit of 115,000 lbs. The crank pins and ends of the shaft are drilled for lightness and the cheeks are also drilled for oil circulation. The crank shaft runs in bronze-backed, Fahrig metal-lined bearings, four in number. A double thrust bearing is also provided, so that the motor may be used either in a tractor or pusher type of machine. Outside of the thrust bearing an annular ball bearing is used to take the radial load of the propeller. The propeller is mounted on a taper.

GEARING

At the opposite end of the shaft a bevel gear is fitted which drives the cam shaft, through a vertical shaft, and also drives the water and oil pumps and magnetos. All gears are made of chrome vanadium steel, heat-treated.

CONNECTING RODS

The connecting rods are tubular and machined from chrome vanadium steel forgings. Oil tubes are fitted to the rods which carry the oil up to the wrist pins and pistons. The rods complete with bushings weigh 5½ pounds each.

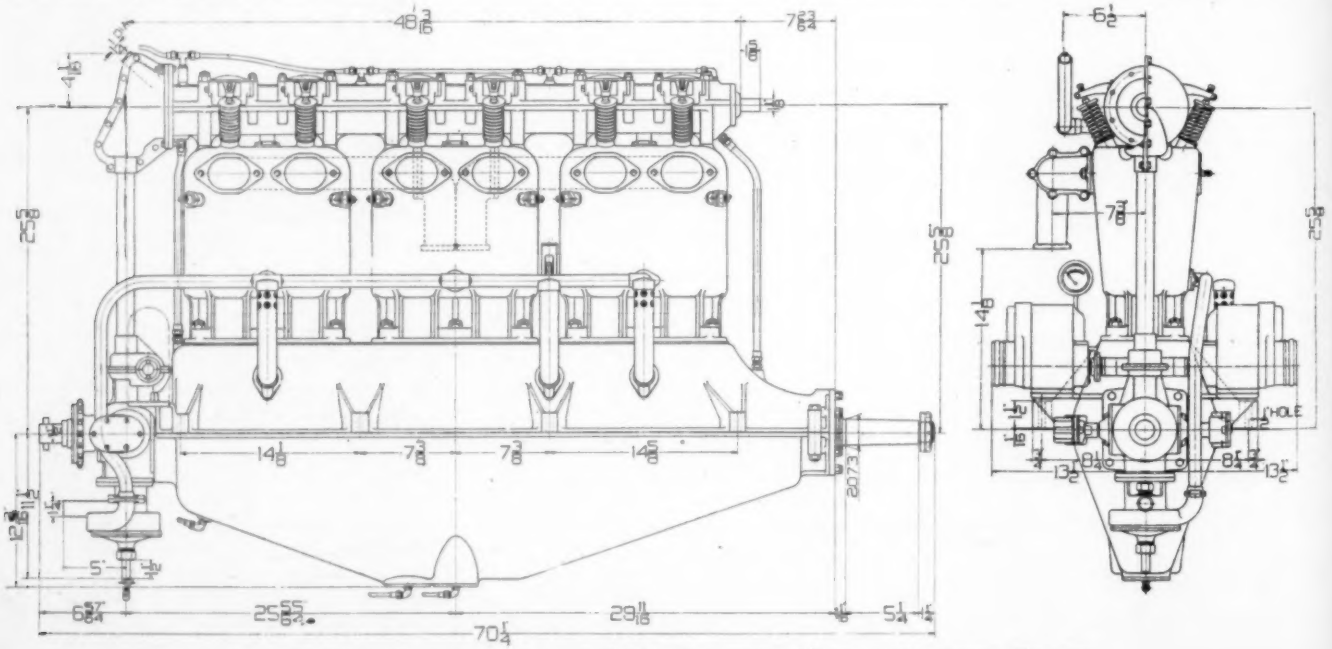
PISTONS

The pistons are made of aluminum alloy and are very light and strong, weighing only 2 pounds, 2 ounces each. Two leak proof rings are fitted to each piston. The wrist pins are hollow of hardened steel and are free to turn either in the piston or the rod.

A bronze bushing is fitted in the upper end of the rod but no bushing is fitted in the pistons, the hardened steel wrist pins making an excellent bearing in the aluminum alloy.

WATER CIRCULATION

The water circulation is by centrifugal pump, which is



SIDE AND END ELEVATIONS OF THE WISCONSIN SIX-CYLINDER AVIATION ENGINE.

mounted at the lower end of the vertical shaft. The water is pumped through brass pipes to the lower end of the cylinder water jackets and leaves the upper end of the jackets just above the exhaust valves.

LUBRICATION SYSTEM

The lubricating system is one of the main features of the engines, being designed to work with the motor at any angle. The oil is carried in the sump, from where it is taken by the oil circulating pump through a strainer and forced through a header, extending the full length of the crank case, and distributed to the main bearings. From the main bearings it is forced through the hollow crank shaft to the connecting rod big ends and then through tubes on the rods to wrist pins and pistons. Another lead takes oil from the main header to the cam shaft bearings. The oil forced out of the ends of the cam shaft bearings fills pockets under the cams and in the cam rocker levers. The excess flows back through pipes and through the train of gears to the crank case. A strainer is fitted at each end of the crank case, through which the oil is drawn by separate pumps and returned to the sump. Either one of these pumps is large enough to take care of all of the return oil, so that the operation is perfect whether the motor is inclined up or down. No splash is used in the crank case, the system being a full force feed. An oil level indicator is provided showing the amount of oil in the sump at all times. The oil pressure in these motors is carried at ten pounds, a relief valve being fitted to hold the pressure constant.

IGNITION

Ignition is by two Bosch magnetos, each on a separate set of plugs fired simultaneously on opposite sides of the cylinders. Should one magneto fail, the other would still run the engine at only a slight loss in power.

CARBURETION

The Zenith double carburetor is used, three cylinders being supplied by each carburetor. This insures a higher volumetric efficiency, which means more power, as there is no overlapping of inlet valves whatever by this arrangement.

All parts of these motors are very accessible. The water and oil pumps, carburetors, magnetos, oil strainer or other parts can be removed without disturbing other parts. The lower crank case can be removed for inspection or adjustment of bearings, as the crank shaft and bearing caps are carried by the upper half. The motor supporting lugs are also part of the upper crank case.

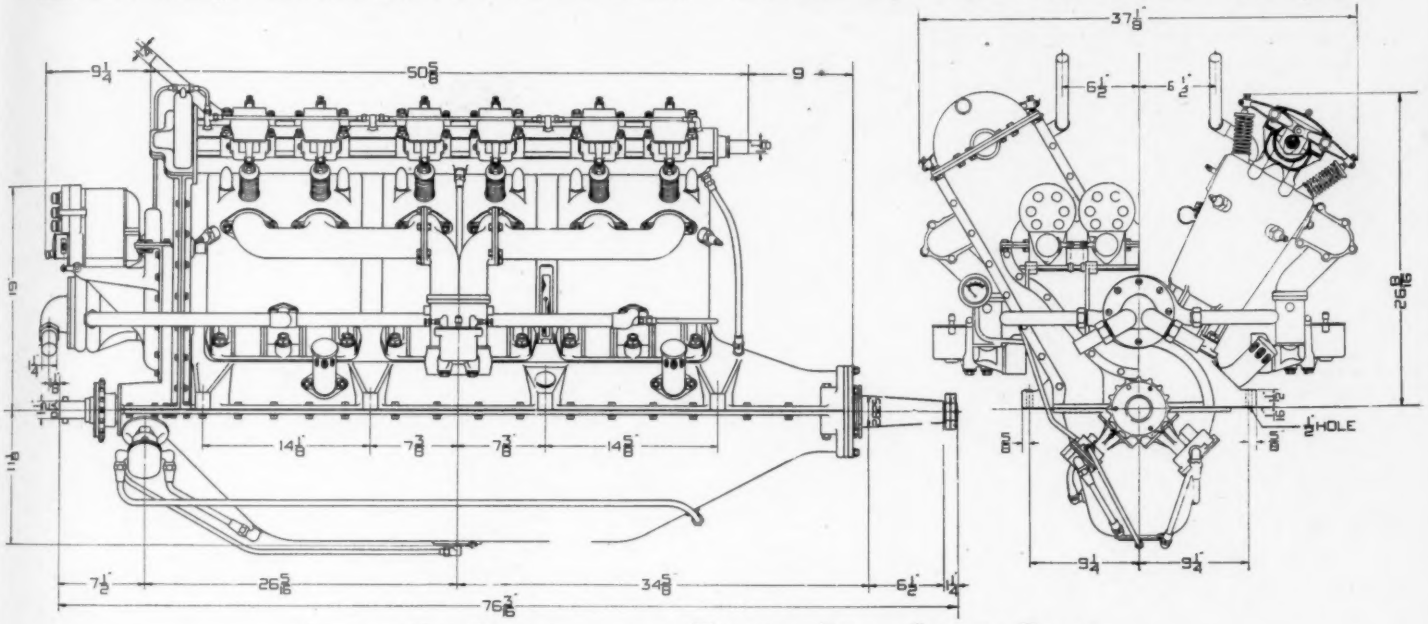
WEIGHTS, FUEL AND OIL CONSUMPTION

The six-cylinder motor, without carburetors or magnetos, weights 547 pounds. With carburetor and magnetos, the weight is 600 pounds.

The weight of cooling water in the motor is 38 pounds. The sump will carry 4 gallons of oil, or about 28 pounds. A radiator can be furnished suitable for the motor, weighing 50 pounds. This radiator will hold 3 gallons of water or about 25 pounds.

The motor will drive a two-blade, 8 feet diameter by 6.25 feet pitch Paragon propeller 1400 revolutions per minute, developing 148 horse-power. The weight of this propeller is 42 pounds. This makes a total weight of motor, complete with propeller, radiator filled with water, but without lubricating oil, 755 pounds, or about 5.1 pounds per horse-power for complete power plant.

The fuel consumption is .5 pounds per horse-power per hour. The lubricating oil consumption is .0175 pounds per horse-power per hour or a total of 2.6 pounds per hour at 1400 revolutions per minute. This would make the weight of fuel and oil, per hour's run at full power at 1400 revolutions per minute, 76.6 pounds.



SIDE AND END ELEVATIONS OF THE WISCONSIN TWELVE-CYLINDER ENGINE.

PRINCIPAL DIMENSIONS

Following are the principal dimensions of the six-cylinder motor:

Bore 5 inches.
Stroke 6½ inches.
Crank shaft diameter throughout 2 inches.
Length of crank pin and main bearings 3½ inches.
Diameter of valves 3 inches (2¾ inches clear).
Lift of valves ½ inch.
Volume of compression space 22 per cent. of total.
Diameter of wrist pins 1-3/16 inches.
Firing order 1-4-2-6-3-5.

The horse-power developed at 1200 revolutions per minute is 130, at 1300 revolutions per minute 140, at 1400 revolutions per minute 148. 1400 is the maximum speed at which it is recommended to run these motors.

TWELVE-CYLINDER ENGINE

A twelve-cylinder V-type engine illustrated here, is also being built by this company, similar in dimensions of cylinders to the six. The principal differences being in the drive to cam shaft, which is through spur gears instead of bevel. A hinged type of connecting rod is used which does not increase the length of the motor and, at the same time, this construction provides for ample bearings. A double centrifugal water pump is provided for this motor, so as to distribute the water uniformly to both sets of cylinders. Four magnetos are used, two for each set of six cylinders. The magnetos are very accessibly located on a bracket on the spur gear cover. The carburetors are located on the outside of the motors, where they are very accessible, while the exhaust is in the center of the valley.

The crank shaft on the twelve is 2½ inches in diameter and the shaft is bored to reduce weight.

Stresses in Propellers Due to Gyroscopic Action

By Alexander Klemin, Assisted by E. P. Warner

Following on Elmer A. Sperry's very suggestive note, considerable discussion has arisen with regard to the stresses in propellers induced by gyroscopic action. It is thought that in existing propellers, when not run at too great a speed and when designed on a conservative basis, there is a sufficient margin of strength to cover such stresses. They are, however, by no means negligible, and, as their evaluation is a comparatively simple matter, it might be added as a legitimate and necessary refinement to the usual propeller strength calculations.

The mathematically correct evaluation of the torques and bending moments produced by gyroscopic action would involve the writing down of Euler's equations for a body with three moving axes, would necessitate a knowledge of the moments of inertia, and also of the products of inertia of the propeller in various positions relative to the plane of symmetry of the aeroplane. A correct mathematical treatment would therefore be unsuitable for practical design. By treating the

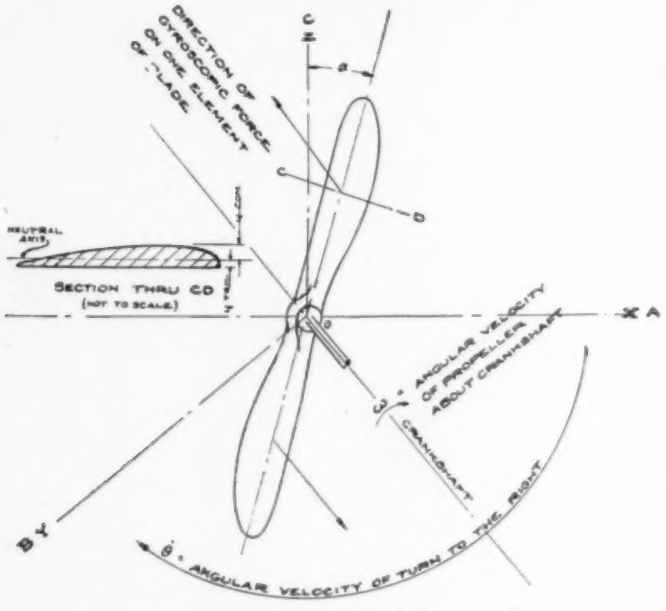


FIG. 1.

various elements of the propeller as masses concentrated at points on a line perpendicular to its axis of rotation and passing through its center of gravity, sufficiently accurate results can be obtained.

Consider a mass $M = \left(\frac{W}{g}\right)$ in the plane XOZ, rotating about the axis OY with an angular velocity ω, while the axis OY and the plane XOZ are themselves rotating about the fixed axis OC with an angular velocity θ, the plane XOZ being momentarily coincident with the fixed plane AOC. M then has a velocity $(r \sin \alpha)\theta$ perpendicular to this plane AOC, where α is the angle between OM and OZ.

If $v = (r \sin \alpha)\ \theta = (r \sin \omega t)\theta$ the acceleration of M around $OC = \frac{dv}{dt} = \frac{d}{dt}(r \sin \omega t)\theta = r\,\omega\,(\cos\,\omega t)\theta$.

Since the plane XOZ is rotating steadily about OC, any point in it has no acceleration with reference to AOC, when AOC and XOZ are coincident.

To maintain M in the plane XOZ, therefore, requires a force F equal to $\frac{W}{g} r\,\omega\,(\cos\,\omega\,t)\theta$ lbs. where W is in lbs., r in feet, ω and θ in radians per sec. This force will have a maximum value when $\alpha = \omega t = 2\pi n$ and $\cos\,\alpha = 1$, that is, when OM coincides with OZ. F then equals $\frac{W}{g} r\,\omega\theta$. The minimum value is of like magnitude, but of negative sign. $F = 0$ when OM coincides with OX. When the mass has passed below the plane XOY the force required will change its direction. The moment of this force about the axis XX' will also fluctuate in magnitude but the sign of the moment will not change.

The direction of the gyroscopic forces and couples acting on the propeller of an aeroplane will at once follow from the considerations of the preceding paragraphs. In Fig. 2 a propeller mounted on the engine shaft and turning clockwise when seen from the rear is represented diagrammatically. In Fig. 2 the machine is performing a horizontal turn to the right so that the plane of rotation of the propeller may be considered as rotating about the axis OC. The gyroscopic forces on the elements of the propeller will then be perpendicular to the plane COA and parallel to the shaft. They will produce on the two blades of the propeller bending moments in opposite linear directions. Considering the section cd of the upper blade, the gyroscopic forces will tend to bend the blade approximately about the axis OO. The upper blade will be bent forward, the lower blade back. Thus the effect of the gyroscopic force will be to increase the bending moment in the upper blade while decreasing that in the lower. As the blades move down from the vertical position the bending moments on the blade sections will decrease and grow in intensity approximately as a cosine function, as in the case of a single revolving mass. When the blades are horizontal the only forces acting produce a twisting moment in the blades.

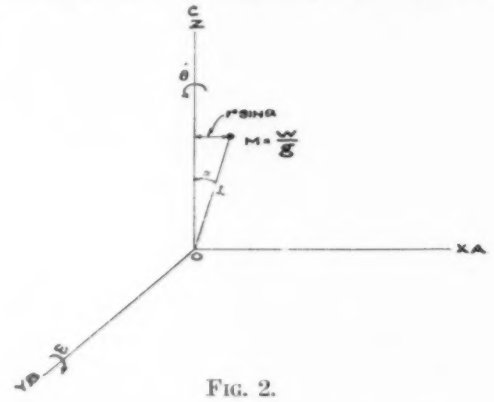


FIG. 2.

The magnitude of this moment cannot be determined without finding the products of inertia of a number of sections through the propeller, but as mentioned previously it is almost certainly so small as to be negligible. The maximum stress due to the gyroscopic torque should always be considerably less than that due to air loads, so that there is merely a fluctuation of stress in the blades, and not a reversal.

The stress in the shaft also fluctuates and alternates in a similar manner, and should be allowed for in designing. Computations of the stress in a typical case will be found at the end of this note.

Turns in vertical plane have exactly the same effect, except that the torque is now a maximum when the propeller is horizontal, since the propeller when in motion is radially symmetrical, and the axes of reference may be canted to any desired angle.

Without accurate record of the time taken by pilots to turn or to flatten out in flight, the figures given by O'Gorman in his note on gyroscopic couples are probably the most useful. For maximum rapidity of turn in a horizontal plane, he assumed a complete circle to be made in 20 seconds, giving an angular velocity of 0.314 radians per second. For maximum rapidity of turn in a vertical plane, O'Gorman takes a speed at which the pilot is just about to be lifted from his seat, and, working on this hypothesis for an aeroplane moving at 70 miles an hour, arrives at practically the same result.

APPLICATION TO AN ACTUAL AEROPLANE PROPELLER

In the strength calculations for a propeller, it is customary to consider the blade divided up into a number of elements, and to allow for the centrifugal forces and thrusts on each element to establish the bending moment diagrams and resultant tensile and compressive stresses. The same methods can be applied in the computation of the gyroscopic stresses.

The propeller whose design is carried through by A. Fage in his book, "The Aeroplane," will serve as a concrete

instance. This was 96 inches in diameter. The maximum blade width was 9¼ inches and the angle of attack 4°. The propeller was designed to be driven at 1100 revolutions per minute by an engine of 90 horsepower.

The gyroscopic force on each element is calculated from the formula deduced above: $F = 2\left(\frac{W}{g} r\,\omega\theta\right)$ where 1100 revolutions per minute $\omega = \frac{1100\times\pi}{60} = 115.1$ and $\theta = 0.314$ for a maximum turning velocity of one complete circle in 20 seconds. The multiplying factor of 2 serves to cover amply the fact that the gyroscopic forces are alternating.

The method of obtaining the centrifugal force and bending moment due to air load at each point is fully described in Bolas' notes. The various forces, bending moments, and stresses are tabulated in the following tables:

TABLE I.

Section.	Radius.	Area (sq. ins.)	Weight of element (Lbs./ft.)	Centrifugal force.	Centrifugal stress.	Air load (Lbs./ft.)	Bending Moment due to air load (in. lbs.)
a	4.0	1.99	0.48	205	105	100.0	72
b	3.5	3.55	0.86	745	210	97.0	442
c	3.0	5.40	1.31	1485	275	66.5	1080
d	2.5	6.72	1.63	2340	345	60.5	1950
e	2.0	9.60	2.38	3260	340	39.0	3050
f	1.5	9.60	2.38	4120	430	10.7	4240
g	1.0	9.30	2.26	4740	510	2.0	5460
h	0.5	12.30	3.00	5150	420	....	6720

TABLE II.

Section.	Gyroscopic force $\frac{W}{2g} r\,\omega\theta$.	Bending Moment due to Gyroscopic Forces.	$\frac{y}{I}$ (ten.)	$\frac{y}{I}$ (com.)	Maximum tensile stress without gyroscopic force.	Maximum tensile stress with gyroscopic force.	Maximum compressive stress without gyroscopic force.	Maximum compressive stress with gyroscopic force.
a	4.32	3	5.60	8.40	512	529	502	527
b	6.77	20	2.80	4.20	1450	1506	1655	1739
c	8.85	56	1.18	1.77	1555	1621	1639	1738
d	9.18	118	0.72	1.08	1755	1840	1763	1891
e	10.71	208	0.38	0.57	1485	1564	1400	1519
f	8.03	329	0.27	0.41	1575	1664	1305	1441
g	5.09	474	0.26	0.39	1930	2053	1620	1805
h	3.38	634	0.17	0 25	1540	1648	1260	1418

$\frac{y}{I}$ (ten.) and $\frac{y}{I}$ (com.) are the reciprocals of the section moduli for the section under consideration. y is the distance from the axis through the center of gravity to the most distant fiber of the section, and I is the moment of inertia of the section about that axis.

STRESSES INDUCED IN THE CRANKSHAFT BY GYROSCOPIC FORCE

Considering the same engine as above, the torque $= \frac{90\times33000}{1100\times2} = 430$ pound feet.

If a tubular shaft is employed $Mt = \frac{\pi}{16} \times \frac{(D^4-d^4)f}{B\times s}$ Assuming a factor of safety of 8 under shearing stresses, and an outside diameter of 2½ inches, we have $\frac{430\times12\times16\times2\frac{1}{2}}{(40\frac{1}{2}-d^4)} =$ 10,000 if shearing stress is to be 10,000 pounds per square inch. We shall therefore use an internal diameter of 2 inches.

The bending moment induced by gyroscopic force at the hub of the propeller, doubling the actual force to allow for the effect of alternation, is 1608 pounds inches.

Then $f = \frac{My}{I} = \frac{1608\times32\ D}{(D^4-d^4)} = 1980$ pounds, and is alternately a compressive or tensile force at the outside radius of the shaft. The factor of safety, under these conditions would be more than three times as great both in tension and in compression as in shear. With a propeller shaft of ordinary practice there should be no difficulty in taking up the gyroscopic stresses.

It is thus apparent that the extra stress in the propeller blade induced by gyroscopic forces amount to no more than 12 or 15 per cent. of those of the air load. Although with a conservative factor of safety such an increase is not too great, it is worthy of computation. There also rises the question whether the turn in 20 seconds would not be greatly exceeded in violence in actual practice. There might also arise the contingency of a horizontal turn combined with a vertical turn, pitching or flattening out. If for instance a pilot coming out of a spiral dive, attempted to flatten out while still turning, there would be a cumulative gyroscopic effect, which might more than double the above figures. Both questions admit of further discussion.

Note on Aeroplane Propellers, Elmer A. Sperry.
Notes on Aerial Propellers, H. Bolas; Technical Report of the British Advisory Committee on Aeronautics, 1911-12.
Note Relative to Gyroscopic Couples on Aeroplanes, Mervyn O'Gorman; op. cit. 1912-13.
Torque in Aeroplane Propellers, A. F. Zahm, *Scientific American Supplement*, March 2, 1912.

Inherent Controllability of Aeroplanes

Two very interesting though extremely mathematical papers, by Professor G. H. Bryan and Leonard Bairstow in the *Aeronautical Journal*, deal with the inherent controllability of aeroplanes. Professor Bryan is one of the great pioneers of the mathematical theories of dynamic stability, and Mr. Bairstow has been one of his chief interpreters. Here again Bryan has developed a new idea in rigid mathematical form, and Bairstow has acted as a "scientific middleman," commenting and simplifying for the benefit of the practical man.

Inherent controllability is defined as the problem of controlling an aeroplane without the permanent exercise of physical effort by the pilot. During the state of transition from straight flying to flying in a circle, a pilot exerts a force to pull over the rudder, and in the usual case it is necessary to maintain some force in order to make a continuous turn. A design of aeroplane is now suggested in which turning having been started, maintenance of turning is obtained without any effort being necessary to keep the rudder in position.

It is true that as far as the pilot is concerned the same result would be obtained by balancing the control surfaces, but the effect on the aeroplane is quite different. In the case of balanced controls, a lateral force is still exerted by the rudder, and so stresses are introduced in the tail structure of the areoplane. On the other hand, in an inherently controllable aeroplane there is no lateral force on the rudder when turning, and therefore no stresses in the tail.

Bairstow points out that the usefulness of this principle is immediately obvious for the case of large and consequently heavy aeroplanes. Unless some such effect of controllability be obtained, a point will soon be reached at which the muscular strength of the pilot must be reinforced by a servo motor. Inherent controllability, or the balancing of control surfaces, or both in combination, may postpone the necessity and avoid a certain amount of complication of mechanism.

The equations of motion of both the longitudinal and lateral group are submitted in the first paper, and the problem is attacked by the two writers from many points of view.

Professor Bryan considers the effects of the rudder, of straight planes with boxed-in ends or vertical partitions, of bent-up planes, and of varying the position of the rudder. The conclusions arrived at are extremely interesting. In an aeroplane with upturned wings with suitable rudder planes, the machine can be steered in a circle without being inclined at any but the smallest angle. If the two principal motions of inertia about axes perpendicular to the line of flight are equal, the rudder exerts no pressure and the system is inherently controllable. He also concludes that in certain cases ailerons may be dispensed with entirely.

When numerical values have been placed in all the equations and a concrete example is worked out, it may be possible to construct a machine which with very slight modifications on standard design to meet the mathematical conditions stated in these papers, but whether the attainment of inherent controllability is advisable from a practical point of view is a matter to be determined.

Efficient Instrument Illumination for Military Night Fliers

By A. G. Hamlin

of the Radium Luminous Material Corporation

An aero scout on night duty, or, as called in England, a "night pilot," has to be able to read his instruments every moment or his safety is jeopardized. But if he is a military night pilot on duty he must also keep out of the enemy's sight. Present methods are not satisfactory in this respect and no one realizes it better than the aviator who has seen military air duty at night. Lieutenant Phil. Rader of the Curtiss Company, who has but recently returned from duty in England, says:

"As I was a 'night pilot' in England on Zeppelin duty for six months, I have a good idea as to what is needed in a satisfactory illuminant for instruments. Electric lights were never satisfactory owing to the fact that they either cast such a blinding glare that you could see nothing else, or they were continually going out, owing to engine vibration. We always had to carry a hand flash lamp for emergency, which was very cumbersome. The only instrument that had luminous paint on it was our compass.

"Before I left England I believe they were going to equip all instruments with luminous paint. When the electric lights failed us, we were in great danger, as night flying is like flying with a blanket over our eyes, and what made it doubly dangerous was the fact that we had a large quantity of high explosive bombs with us."

This uncertainty can be done away with. The elimination of the expense of electric equipment and of its weight from the machine would be progress enough to pay for research work in this direction, while the addition of certain illumination that could not possibly attract the eye of an enemy would be of extreme value in military aviation. The Sperry gyroscope compass illuminated with a radium compound has been used in Europe for over a year. The result to date of experience with this compass has been that every Allied aeroplane is equipped with one instrument at least, having this new method of illumination and will probably have a full equipment as soon as possible.

Instead of throwing light from an exterior source upon the instrument or object to be illuminated, the light and its source, combined in one body, are applied directly to the part that is to be illuminated. Such a combination might be called a self-luminous compound, but as the compound under consideration here has for its chief constituent the rare metal radium, the material is generally called a radium compound or radium luminous material.

The principal that light is vibration has been worked on here to one of its finest applications. A crystalline sulphide of zinc has been made so that its hexagonal crystals will vibrate under certain rays, such as the ultra-violet rays or the alpha particles of radium, until they produce enough bluish-tinted light to make a spot of the compound, one-eighth of an inch in diameter, visible at a distance from it of ten feet.

Such a luminous compound was made possible by better acquaintance with the element radium. It is different from other luminous paints, in fact it is the only kind of paint known that is not dependent upon anything outside itself for the cause of its luminosity. Everyone has discovered the limitations of the old kind of luminous paint, so it is necessary to make the difference between these radium compounds and the old kind distinctive.

F. Harrison Glew, in a lecture recently delivered before the Optical Society of Great Britain, says, in part:

"Luminous paints are in great demand, especially for naval and military purposes. There appears to be some misconceptions as to the various purposes and relative advantages of different kinds of paint, some of which are excited by daylight which they are capable of storing up, slowly emitting the same at night. However, the luminosity falls off very rapidly after the first hour or two after exposure. This class of paint was originally prepared in the days of alchemy by calcining crystals of sulphate of barium with organic matter, such as flour, thus converting the sulphate into sulphide. This was originally prepared at Bologna, and is known as Bologna Phosphorus.

"Another form of daylight paint was made by roasting oyster shells with sulphur by Canton, and is known as Canton's Phosphorus. This paint was very much improved by Balmain, it being found that the addition of very minute quantities of other substances, bismuth is one, added very greatly to the luminosity."

These old style luminous paints had many faults. They either became exhausted quickly or required charging by exposure to light in such a way that they were useless. On the other hand since the one-half life of radium is known to be seventeen hundred years, it will in combination with the phosphorescent zinc sulphide give the self-luminous compound of today, which while it is not absolutely permanent, because the zinc sulphide is prone to decay under the continual bombardment of the radium rays, is permanent enough for all practical purposes, and if compounded properly in accordance with the approved formulas, should be guaranteed by the manufacturer of it to last at least five years. Some grades last ten, others for thirty years, the lasting quality being dependent, not upon the price, but upon how little radium is used, and consequently upon how low the excitation of the crystals' faces of the zinc sulphide is.

The United States Government requires a guarantee of only two years because the grade of material used must have a very high radio-active content to meet their specification for luminosity. The English Government is grading self-luminous compounds by radio-active content now as they did when the radium sensitiveness of all zinc sulphides was the same, although now all manufacturers of luminuous compounds have their own secret formulas as the quality of the zinc sulphide is their only protection against competition. The resulting zinc sulphides vary greatly in crystal stability and ray sensitiveness, so the English will soon have to take life and luminosity as their gauge for standard, as the American manufacturers are doing, instead of a radio-active content of 0.2 or 0.4 milligrams of radium bromide (radium bromide is approximately 53 per cent. of the U. S. Standard for radium element).

Anyone who has seen the Sperry Air Compass, the English Mark 7, or the Creagh-Osborne Prismatic Compass is familiar with the appearance of radium luminous material both at day and night. It is necessarily white, and in the daylight might be mistaken for thick cream-white enamel. For daylight use it shows up best on a black background, therefore the floating mica cards of the compasses mentioned have a coating of a dull black solution before the hand-painting of luminous material is begun. The best illustration for one not familiar with these compasses is the luminous Ingersoll watch. The effect of radium luminous material on a black background is shown very nicely. White or black is every bit as legible as black on a white ground once it is familiar.

By night, radium luminous material glows weirdly. Its outline seems alive. It is alive, and if observed through a magnifying glass the millions of rays released by the disintegrating radium can be seen as they sky-rocket off. It looks like a concentrated milky-way on a clear, dark night. Because of the general casting off of minute sparks in all directions, the edges of the numbers and of lines appear rather fuzzy in the dark and care must be taken to maintain a certain space between lines or their appearance in the dark will be as one continuous line.

The question has been raised by some users of luminous compounds whether the radium contained in the material was injurious to the eyes. Radium in concentrated quantities certainly is. Ten milligrams exposed to the eyes for one minute at a distance of three feet will cause general lassitude and a dull pain in the head and eyes, but the millionth part of a gram that is in the material used on compasses and watches, physicians of repute in radium therapy assure us, will have absolutely no effect of this kind.

Luminous compasses have already proven their worth in aviation and it is hoped that the next few steps necessary for the full equipment of the instrument board will be taken without loss of time. The oil gauge, the aneroid, the inclinometer, barometer, ammeter, all can be treated with this new illuminant. The safety of the military night aviator depends upon it.

Course in Aerodynamics and Aeroplane Design*

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PART 1—SECTION 5

Comparison of Standard Wing Sections

The National Physical Laboratory has often been criticized in the past for not stating, in spite of its voluminous reports, what the "best" wing section is. There is no such thing as a "best" section. There are very bad wing sections giving abnormally high resistance and low lifting power; there are sections giving high lift at big angles of incidence, but too great a resistance at small angles, others giving a low maximum lift, but very suitable for high speeds; others give a very stable motion of the center of pressure, but sacrifice aerodynamic efficiency. The selection of any particular form depends on the performance required of the machine in view.

As the result of several years' practice, modern machines all tend to a few types of wings, although there are numberless small modifications by individual designers. We shall attempt to classify and give data for what may be called Standard Sections, using the (pounds, per square foot, per miles hour) system of units for force coefficients.

Representative Wing Sections Selected

These have all been taken from the N. P. L. and Eiffel laboratories. German laboratories have done a great deal of work with reference to propeller sections, and also have carried out tests on wing shapes of a great many forms, but the present selection is representative and sufficient for all practical purposes. When a designer wishes to introduce slight variations in the standard forms, it will be always necessary for him to submit his variation to a special test, so that a complete collection of every form that has ever been submitted to publication would be useless.

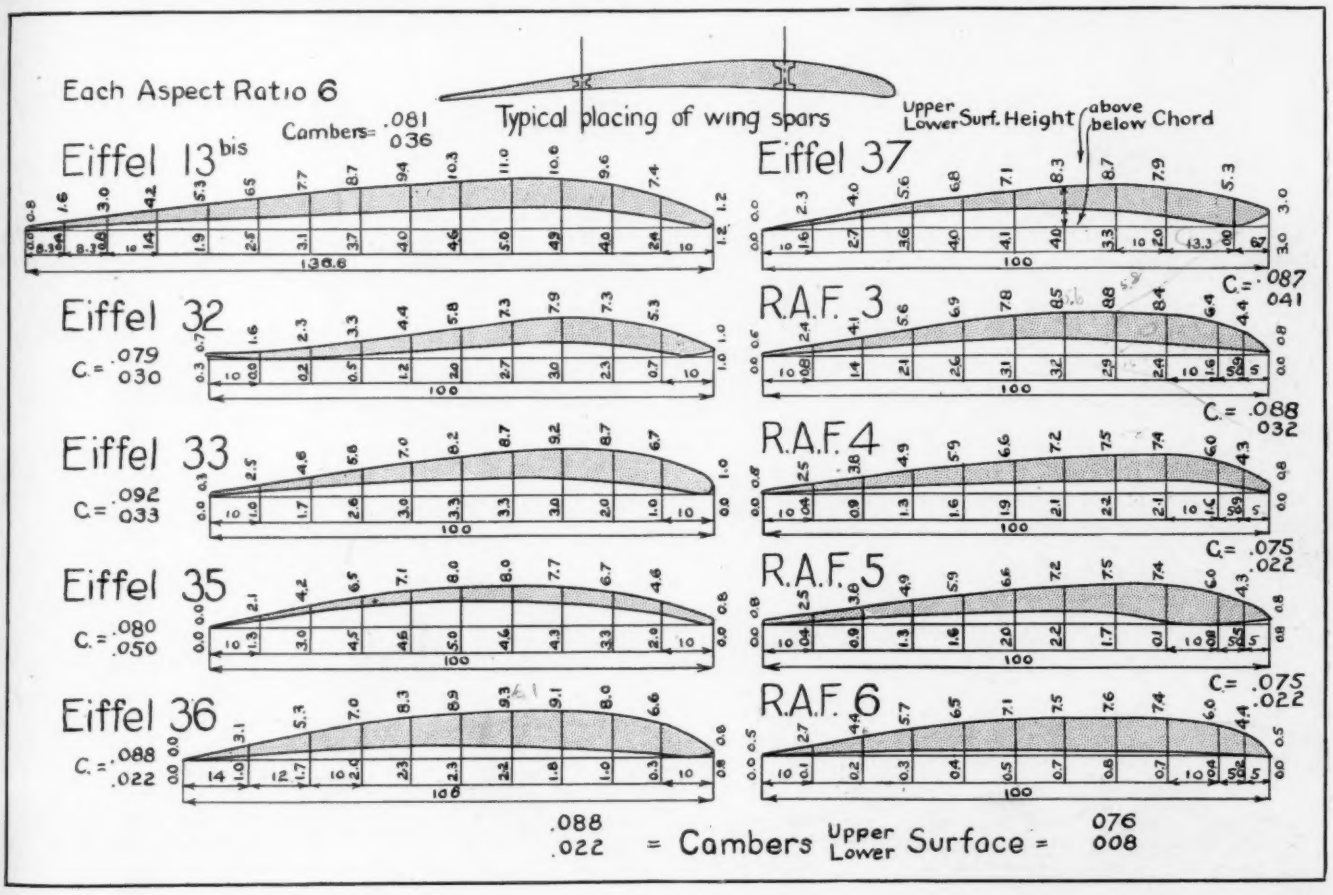

FIG. 1.

The sections we have selected are: R. A. F., No. 3, 4, 5, 6 and Eiffel 13 bis., 32, 33, 35, 36, 37. In Fig. 1 these forms are represented on a uniform plan, with complete dimensions, and values of camber. The camber of the upper surface is defined as ratio of maximum height above chord to chord length, and the same definition holds for the lower surface. The hollowing out of the lower surface, as we shall see later, has little importance —it scarcely affects the Lift/Drag ratio or the angle of incidence for the burble point, but it increases the lift about 17 per cent at any angle when a plane lower surface is cambered out to a camber of 0.06. An increase in lift obtained in this way involves a dangerous weakening of the wing. In Dr. J. C. Hunsaker's opinion, a decrease of camber below 0.05 or an increase of camber above 0.08 for the upper surface is disadvantageous in practice. Broadly speaking for the incidence

* This Course commenced in the August 1, 1916 issue of AVIATION AND AERONAUTICAL ENGINEERING, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for aeroplane design, and present the design of standard machines fn complete, simple and systematic form.

giving maximum Lift/Drag ratio, the lift for upper surface camber of 0.08 may be twice as great as for a camber of 0.05, but the Lift/Drag ratio is diminished by nearly 25 per cent. We shall deal later with the effects of varying the position of the maximum ordinate of the upper surface; the best position for this maximum ordinate is about ⅜ of the cord from the leading edge.

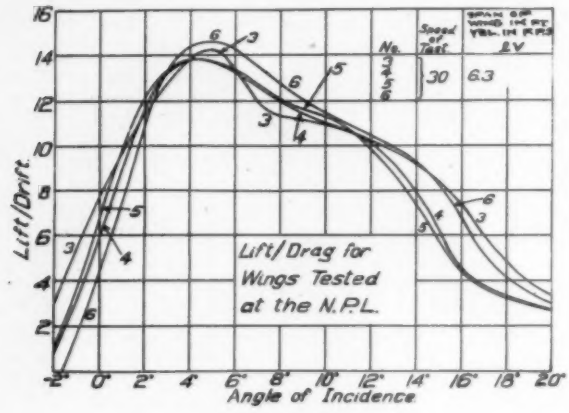

FIG. 2.

Complete Data Presented

In Figs. 2 to 8 are given curves for Lift, Drag, Lift/Drag and Center of Pressure motion for these wings. In Fig. 9 a comparative table has been drawn up giving maximum Lift coefficients and corresponding angles; maximum L/D and corresponding angles; the angle of incidence and the corresponding L/D for a lift coefficient of value .00086, and also the value of V for the tests from which these results have been taken. This is as complete data as the designer can possibly require. The aspect ratio for all these sections is 6.

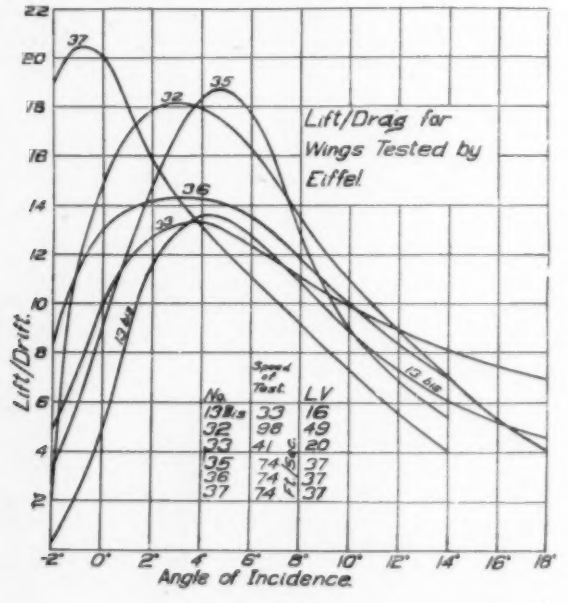

FIG. 3.

We shall deal later with the effects of variation of scale and speed. At this point it is sufficient to state that whereas the lift coefficient is unaffected by variation in the product lV—span of wing in feet times velocity of relative wind in feet per second—the drag coefficient and the L/D ratio are both improved by increase in lV. The N. P. L. tests and Eiffel's tests are unfortunately not concordant in this respect. Eiffel's experiments were made in a larger wind tunnel and at higher speeds, and if the same wing were tested at the N. P. L. and Eiffel's laboratory, the latter would give better results for both drag and L/D. Since in an actual machine the product lV will be very much greater than the values of either laboratory, the full size performance will always be somewhat better than the one deduced from these experimental results, particularly where an N. P. L. section is used. Employing the exact figures of our curves, the designer will be proceeding on a very conservative basis. Certain experiments of the N. P. L.—which we shall deal with fully later—permit us to make approximate corrections. These have been made in the last column of Fig. 9.

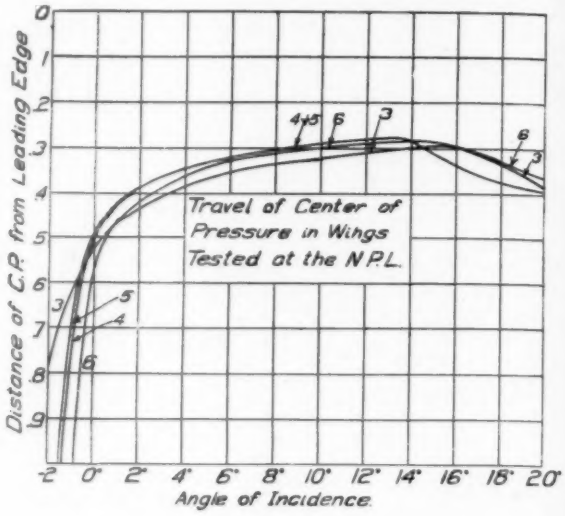

FIG. 4.

Points of Interest in Considering a Wing Section

In discussing the merits of a section, there are so many points at issue that it is only in an actual design that it is possible to enter fully into all. Study of the data submitted will be of much more use if the following features are always kept in mind:

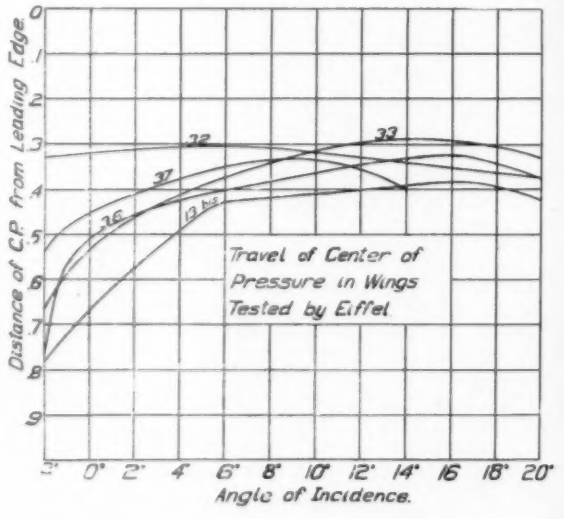

FIG. 5.

(a) The maximum value of L/D, and the corresponding K_y. A machine in normal horizontal flight will generally be navigated at the angle giving the best L/D ratio, which is therefore most important from an efficiency point of view. The value of the lift coefficient at the best L/D is of importance. The greater the lift at this ratio the smaller the area of the wing surface required for a given load. With a heavy machine, such as a flying boat, or an armored battleplane, a big lift coefficient is essential. With a speed scout or a light reconnoissance machine, a small value of K_y at best L/D is what is needed, so that with a sufficiently powerful motor a small

wing surface may be used and a great speed attained.

(b) The maximum K_y has a bearing on a number of points. The greater the maximum K_y the slower is the speed at which a machine may fly and land. If the maximum K_y, or simply

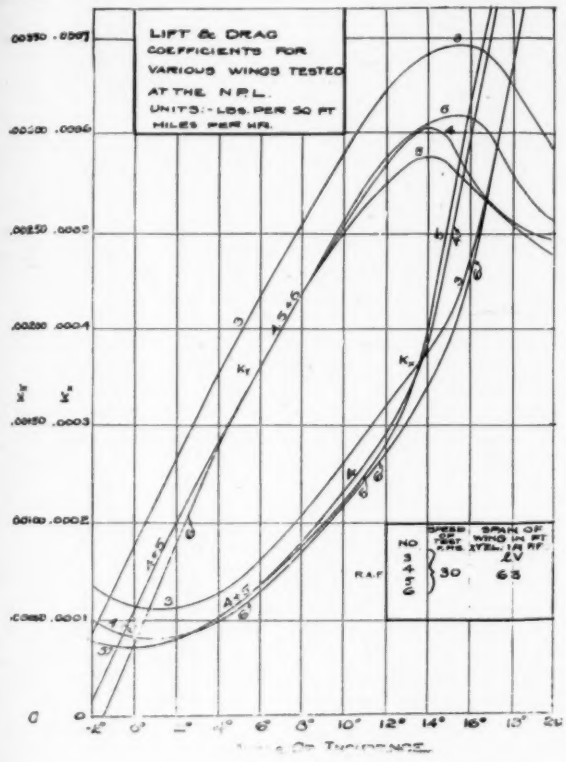

FIG. 6.

large values of K_y, are accompanied by a good L/D ratio, then the machine will be efficient and ready in climbing—though the best angle of climb is by no means the angle of maximum K_y, as we shall see later in considering the economic laws of flight.

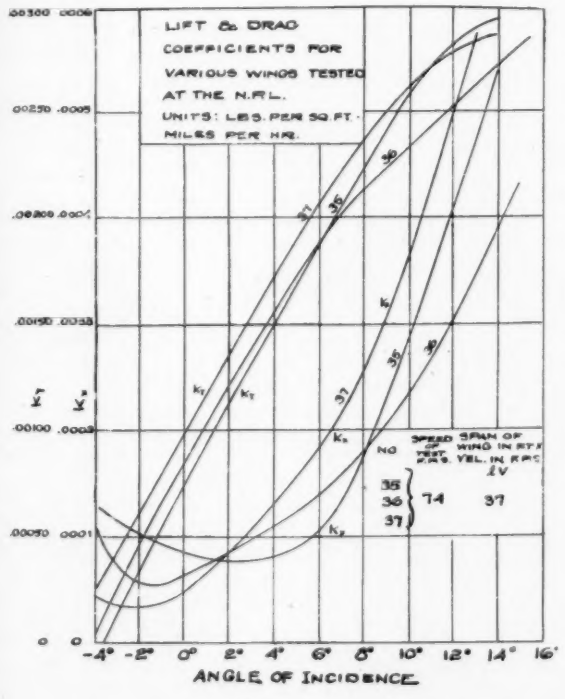

FIG. 7.

(c) The maximum K_y should occur at as high an angle as possible, so as to give a big range, and possibility of a large speed variation.

(d) The angle of maximum lift is termed the burble point, as we know, and also the "stalling" angle. It is very important to consider what the shape of the lift curve is in the neighborhood of this angle. If the lift past the burble point falls off very rapidly, the pilot may easily stall the machine. He may increase the angle of incidence too far and find his sustaining power fall off dangerously. A wing with a flat lift curve at the burble point will avoid such danger.

(e) The L/D ratio at small angles of incidence and small values of K_y determines whether the machine is really suitable for high speeds. We have arbitrarily chosen $K_y = 0.00086$ as the value of comparison, and it can be seen from the tables how widely L/D varies at this point. A machine with good maximum L/D and a high maximum K_y might be totally inefficient at high speeds.

(f) The movement of the center of pressure is important at low angles. If at low angles the center of pressure moves

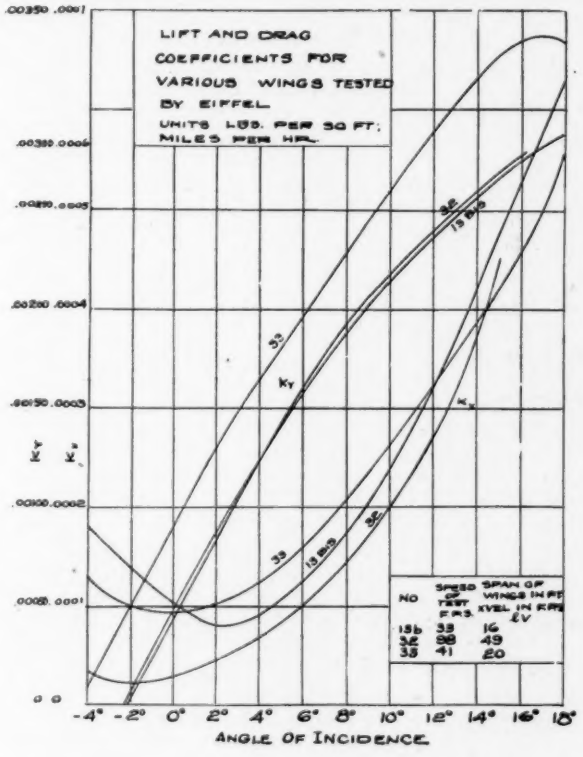

FIG. 8.

steeply back towards the trailing edge, the machine will have a tendency to "dive," provided for, of course, by fixed stabilizing surfaces on modern machines. If the center of pressure remains stationary, on the other hand, as in Eiffel 32, it will maintain its attitude at low angles, and will not tend to dive even with small stabilizing surfaces and inefficient or inoperative elevator. Similar considerations apply to "stalling" angles.

(g) In addition to the separate consideration of these points, there yet remains the appraisal of the wing throughout its performance. The designer must see how far one point of excellency conflicts with other requirements; what the range is. The ideal wing would give great lift and efficient climb, high efficiency in normal flight, and high efficiency at maximum speeds.

(h) A wing may be entirely satisfactory from an aerodynamic point of view, and yet fail to satisfy as regards structural requirements. In Fig. 1 is shown a typical arrangement of the wing spars. It is important that the points where the wing spars are likely to be placed, the wing should have sufficient thickness to permit the use of reasonably deep spars without exaggerated width. A wing may indeed have sufficient thickness at two points for good spars to be placed, yet these points may be totally unsuitable. They may be too near together, so that a weak overhanging construction or excessive spar loading is the result, or too far apart so that too long an unsupported rib section results.

There could be no better plan for the reader to whom the

FIG. 9 COMPARATIVE TABLE OF STANDARD WING SECTIONS

LIFT COEFFICIENTS IN LBS. PER SQ. FT.; MILES PER HR.

ASPECT RATIO 6

Span of Wing in Feet x Relative Wind in Ft/Sec. lV.	CAMBER		WING	MAX. K_y			MAX. L/D			K_y = .00086		Max. L/D —corrected app. to full size mach. in actual flight in accordance with exp'ts at the N. P. L.
	Upper	Lower	Section	Angle	K_y	L/D	Angle	K_y	L/D	Angle	L/D	
16	0.081	0.036	Eiffel 13 Bis.	.....	.....	....	4.3°	0.00129	13.6	1.9°	11.4	14.5
49	0.079	0.030	" 32	.....	.....	....	3.0°	0.00103	18.2	2.2°	18.0	18.2
20	0.092	0.033	" 33	16.8°	0.00336	7.2	3.5°	0.00152	13.4	−0.2°	9.5	13.6
37	0.080	0.050	" 35	14.6°	0.00296	5.2	4.8°	0.00165	18.7	0.5°	10.6	18.9
37	0.088	0.022	" 36	.....	.....	....	3.1°	0.00142	14.3	0.0°	13.1	14.3
37	0.087	0.041	" 37	14.1°	0.00288	4.0	−0.8°	0.00086	20.4	−0.8°	20.4	20.4
6.3	0.088	0.032	R.A.F. 3	15.7°	0.00347	7.8	5.0°	0.00195	14.3	−0.1°	7.4	18.1
6.3	0.075	0.022	" 4	14.0°	0.00304	8.0	4.2°	0.00142	13.8	1.4°	10.3	19.2
6.3	0.075	0.022	" 5	14.2°	0.00288	7.0	4.2°	0.00142	13.8	1.4°	11.0	19.2
6.3	0.076	0.008	" 6	15.4°	0.00310	7.8	4.9°	0.00157	14.6	1.9°	10.4	18.5

subject is comparatively new than to go through all the wing sections presented with reference to these eight points.

Consideration of a Few Sections in Common Use

We shall consider a few sections in this manner ourselves.

Take Eiffel 37, for instance. Its maximum L/D—the highest of any section considered here—is 20.4, occurring at 0.8°, which is still a good many degrees from the angle of no lift, though its center of pressure motion at this point is rapid. Its maximum K_y is small (0.00306), with a L/D of only 4.0. Such a machine would be unsuitable for heavy loading, but would be excellent for a high speed racing machine, in which little variation in speed would be required. It would, however, have to land at comparatively high speed because of the low maximum K_y. The structural difficulties would be considerable, because there is insufficient thickness in the wing for the rear spar.

Eiffel 32 is an excellent all-around wing. Its maximum L/D, uncorrected for scale, is high 18.7. It has fairly good values of L/D for high lift coefficients. Its center of pressure motion is almost nil.

R. A. F. 3 has the highest value of K_y (0.00195) at maximum L/D. It would be suitable for a heavy flying boat. At small values of K_y, on the other hand, its L/D is very small. It would be unsuitable at high speeds. Structurally it is excellent.

R. A. F. 6 would also be a good all-around wing, not capable of sustaining the heavy loads of R. A. F. 3, or given the high speed of Eiffel 37, but compromising usefully.

References for Section 5

Eiffel: Nouvelles Recherches Sur la Resistance de l'Air et l'Aviation.
British Report, 1912-1913, No. 72, Report on the Results of Tests of Four Aerofoils.

Book Reviews

THE AIRMAN

Experiences While Obtaining a Brevet in France

By Captain C. Mellor, R. E.

(John Lane Company. Price $1.00. Pp. 123)

This book containing the experience of a young Englishman of the Royal Engineers who learned to fly some time before the war, makes most interesting reading, and gives useful tips to the beginner in flying. Anyone who is hesitating whether he should learn to fly or not will be convinced that he should after reading the description of Captain Mellor's pleasant and mildly exciting first efforts.

THE AEROPLANE

By A. Fage

(J. B. Lippincott Co. Price $2.00. Pp. 134)

A new edition of this book has been recently published and may be recommended for the absolute beginner and for the comparative expert. The subject is covered with thoroughness for so small a work, although the practical details of design, such as weight estimation and stress calculations, are passed over briefly or omitted entirely.

The volume opens with a brief explanation of wind structure and the methods of measuring wind velocity. It then passes on to the consideration of pressures on flat plates, wires, and stream-line struts, and to the forces on an aeroplane wing. Curves from the N. P. L. are freely used to show the effect of aspect ratio, biplane interference, etc. A description of the method of constructing a wing is appended. A chapter treats of construction and, after a few preliminary remarks, is devoted to the description of a number of standard machines of a somewhat older type, illustrated by photographs.

The chapter on equilibrium is of great value. Turning, gliding, and the equilibrium of forces in machines of different types and under different conditions are taken up and carefully examined in turn. The section on stability, while concise and accurate, is simply a summary of Mr. Bairstow's report in the Advisory Committee's publication for 1912-13. It may be questioned, too, whether the engineer, to whose attention the book is avowedly directed, will be able to follow without great difficulty the mathematics employed, for which proficiency in solid analytic geometry and the theory of imaginaries is necessary.

Mr. Fage's right to speak with authority on propellers is unquestioned, and he has given us in the present work one of the most lucid and complete treatments of the subjects ever published in English. Every phase of design is considered, including the determination of stresses. The results of the propeller experiments at the National Physical Laboratory are also summarized.

The volume closes with a chapter on engines. No profound study of this subject is attempted, but half a dozen typical engines are described, and there is a summary of modern practice in respect of M. E. P., piston speed, etc.

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED SEPTEMBER 12, 1916.

1,197,746. Filed Sept. 18, 1915. To Henry Kleckler, Buffalo, N. Y. A frusto-conical hydroaeroplane wing pontoon.

ISSUED SEPTEMBER 19, 1916.

1,198,471. Filed Dec. 22, 1914. To Robert S. Moore, Washington, D. C., assignor to Gyro Motor Company. Rotary gas engine.

Plans for Training Aerial Reserve Corps and National Guard Fliers

The exact intentions of the Aviation Section of the Signal Corps, U. S. A., in the matter of training civilians for the Aerial Reserve Corps and National Guardsmen are outlined in the following interview, secured by AVIATION AND AERONAUTICAL ENGINEERING from the officers of the section in Washington.

"The press statement," said one of the officers at the direction of Lieutenant-Colonel George O. Squier, chief of the Aviation Section, "with regard to the training of one thousand aviators is incorrect. It will be the intention to train as many reserve aviators as possible, whether this number will be a thousand or less will depend upon the facilities and personnel available.

"The training of reserve aviators will fall into two classes, Reserve Military Aviators who will be trained at civilian flying schools, and National Guardsmen. When reserve aviators are thoroughly trained they will, if satisfactory, receive commissions as officers in the Officers Reserve Corps.

"For these men the civilian schools will be utilized for preliminary training and Army aviation schools will be formed as rapidly as necessary to take care of the applicants. Any civilian who wishes to join the Officers Reserve Corps as a Reserve Military Aviator, should send in his application to the War Department at Washington. He will then be examined by a medical officer and also, if it is possible, by an officer of the Aviation Section of the Army, who will try to determine whether he is fit to make an aviator. If he is accepted he will be ordered to a civilian school where he will be put through preliminary training under the supervision of an inspecting officer, either living at the field or making frequent visits. This training may be stopped at any time at the discretion of the officer who makes the inspections, if it should appear that the candidate is either physically, psychologically, or mentally unfit to be an army flier.

"The training in the civilian school will carry the candidate past the preliminary flying test that we have drawn up, which is very simple though a trifle more difficult than the test of the Federation Aeronautique Internationale. The latter test was devised years ago, and simply shows that a man has been able to get into the air and get down again safely. Our preliminary test requirements will be made public in a few days. This training will be paid for by the government through its arrangement with the civilian schools. There has been a certain amount of debate as to what the cost of this training may amount to, and we have made arrangements to keep careful records of the expenses of each man's training, and the amount we pay the schools will be based upon that record. It is an erroneous impression that we have fixed any particular sum as the amount to be paid the civilian schools. In everything we undertake we keep before us always the fact that our chief duty is to encourage aeroplane and aeroplane motor manufacturers. However, we believe that civilian schools ought to be able to put pupils through our preliminary tests for about $500.

"When these are completed, the candidate may either be ordered to an army station or to continue his work at the civilian schools under direct military instruction until he is ready to take his Reserve Military Aviator's tests. These require a considerable degree of skill as a pilot, though they are not so difficult as the Junior Military Aviator's tests that the army pilots take.

"When the Reserve Military Aviator has passed his tests, he will be commissioned a first lieutenant in the Officers Reserve Corps. He will then be required to report fifteen days every year for instruction and practice at one of the army flying fields, during which time he will receive the same pay and allowances as an officer of the same rank in the Regular Army.

"We expect to train 297 R. M. A. First Lieutenants and about 2,000 mechanics, truck-drivers, etc. These men will be trained as individuals, and in case of war or threatened war they may be summoned and put into one of the Regular Army flying units, or made into separate units of their own. In this way we hope to get individual fliers and mechanics who will be on call in case of need.

"The Militia problem is different. Any success in aviation in the Militia will depend primarily upon trained units, able to take the field as units.

"If any State wishes to form an Aero Company, the Adjutant-General should select the man best fitted to command it and his second in command, and submit these men to the physical tests for Reserve Military Aviators laid down by the Chief of Division of Militia Affairs.

"They will then be sent at the Government's expense, to the Signal Corps Aviation School at San Diego, Cal., where they will receive the same course of instruction as is now given to officers of the Regular service. They will take their Junior Military Aviator's certificates and then be sent back to the State where it will be their duty to enlist their men and secure one serviceable aeroplane.

"When they have six officers and thirty-nine men, two of the officers holding J. M. A. certificates, they will receive probationary recognition from the army, which will be continued about a year. Gasoline and oil will be supplied by the Federal Government during the period of probationary recognition. Using the machine with which the State has supplied them, they will be expected to train the four officers who have not had the San Diego schooling as well as the mechanicians.

"At the end of one year, or sooner if the company desires it, a second inspection will be made, and if the company possesses the required number of aviators and the necessary enlisted personnel, it will receive complete Federal recognition and the allotted complement of aeroplanes, motor trucks and other equipment will be furnished by the Federal Government.

"Congress has appropriated $76,000 for the training of Militia Officers. This will be used in the training of those who apply to go to San Diego. Besides that money the Division of Militia Affairs has about $400,000 out of its general appropriation for all arms, cavalry, infantry, artillery, etc., which can be used for equipping Militia aero companies. It is thought that this sum will be ample. However, if it is found that this sum is not sufficient, additional funds will be requested from Congress during the session beginning in December.

Switzerland Wants Strong Aviation Corps

In the *Revue Militaire Suisse* for August there appears an interesting article on the Swiss aviation service. Its most significant point is in reference to the decrease of cavalry.

After dwelling upon the enormous progress developed in military aviation since the beginning of the war, the Swiss General Staff states that "this rapid advance compels us to greatly increase the number of our military aircraft if we wish to be abreast of conditions in this respect. If it (aviation) does not progress as rapidly as some would like, the reason must be sought not only in technical difficulties but also in the expense which the establishment of this new arm entails."

While recognizing the great value of dirigibles, the General Staff believes that "for us, this means of combat is still beyond our reach on account of the great expense which it involves." As for captive balloons, their rôle, which was uncertain at the beginning of the war, is now fixed as an agency for the observation of artillery fire.

It is moreover possible to counterbalance the expenses required for the aviation service by the decrease of an arm which is also very expensive and whose rôle in the present war has been insignificant. The circular of the General Staff tells us that "one of the principal functions of aircraft consists in making reconnaissances; they have shown themselves so well adapted to this purpose that *they have almost entirely supplanted the cavalry for distant reconnaissances.*"

Is this a simple academic statement or must we see in it—since we are talking about aviation—a hint of the decrease of the cavalry! Even before the war, we were taught that the principal rôle of the cavalry was not combat but exploration. If it has really been supplanted in this domain by the aviators, we may well ask ourselves what purpose is served in maintaining at enormous expense a large force of cavalry. We have good infantry, artillery and engineer troops; but this infantry and artillery are blind because the traditional eye of the cavalry is powerless to pierce the curtain of the modern service of security. In order that our infantry and artillery may be able to fight, they must see. In order that they may see, they must be given the modern implements of exploration and observation, the aeroplane and the captive balloon. This can be done at relatively slight expense. Our General Staff has understood it and our people will also understand it.

War Department Asks Addresses of Civilian Aviators

AVIATION AND AERONAUTICAL ENGINEERING has received the following list of 817 civilian aviators from the office of the Chief Signal Officer, Washington, D. C. Lieut.-Col. George O. Squier, in requesting us to publish this list, writes:

> "There is inclosed, herewith, a list of names of persons who it is understood have flown heavier-than-air machines in the United States. The addresses of few of these persons are known. Can you, through your journal or otherwise, make this list public, and at the same time ask those enumerated to communicate with the Officer-in-Charge of the Aviation Section, Signal Corps, War Department, Washington, D. C.?
>
> "Their letters should state:
>
> A. Nationality.
>
> B. Age.
>
> C. Type of aeroplane and control they have flown.
>
> D. Whether or not they desire service with the United States Army."

It is of the utmost importance that the War Department should be able to secure a complete list of American aviators with their addresses, for its use in case of war or threatened war.

Figures before name are Aero Club License numbers.

A

Acosta, Bert
215 Adams, Allen S.
Adams, Baxter A.
294 Adams, Baxter Harrison
Adams, Clarence
Adams, W. F.
218 Aldasoro, Eduardo
217 Aldasoro, Juan P.
Alden, John E.
335 Alexander J. Morrow
Allinio, P.
78 Alvarez, Francisco
Ambrose, Charles
Ando, C.
Andrews, Thornwell
124 Andrews, W. D.
Appold, S. A.
Apte, H. J.
Armstrong, E. R.
Arndt, Edw. F.
198 Arnold, George H.
Astor, Vincent
Atherton, W. S.
98 Atwater, W. B.
33 Atwood, Harry N.
Auckerman, Frank
Autin

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Babcock, W. C.
Bach, James J.
Bailey, J.
Baker, G. H.
7 Baldwin, Capt. Thos. F.
139 Barlow, Floyd E.
Barmeler, Geo.
Barnes, Z. T.
Barnett, A. E.
9 Bass, Capt. Ernest C.
Bassow, Henry
66 Bates, Mortifer F.
193 Baysdorfer, Chas.
Beach, A. C.
99 Beachy, Hillery
27 Beachy, Lincoln
349 Beasly, Percy C.
41 Beatty, Geo. W.
Beckly, Wm. A.
344 Beckwith, E. P.
137 Beckwith, Sidney F.
168 Beech, Alex. C.
Beers, Earl
40 Beers, Wm. C.
158 Belcher, Osmond T.
196 Bell, Dr. F. J.
201 Bell, Grocer E.
Belory, P. P.
Belt, P. P.
Belton, Kaid
Benedict, C. Ray
Benner, Enoch
Bennett, E. D.
Benoist, Tom W.
169 Bergdoll, Grover C.
Bergdoll, Louis J.
222 Bergenthal, Klaus A.
109 Berlin, C. A.
Bernie, B.
Best, Joseph
Billard, Phil.
246 Bixler, John A.
Blakely, H. L.
Blakely, Harold W.
230 Blasier, Arthur
230 Blasiaer
206 Bleakley, Wm. H.
Boandette, Joseph
Boddy, A. J.
Boling, W. E.
79 Bolognesi, Alfred
Bonette, C. C.
Bonner, G. T.
47 Bonney, Leonard W.
Boquels, Joe
Bosdek
157 Bouldin, Wm., 3rd.
322 Bounds, Overton M.
257 Bowersox, Winfoeld E.
Bradford, Doyle
Bragg, Caleb
248 Bressman, A. A.
Brewer, E. D.
307 Brewer, Griffith
Brewer, Roy
340 Briggs, Alfred W.
46 Brindley, Oscar A.
Brinker, H. S.
Britt, Edward
Broch
Brock, Walter L.
135 Brodie, Otto W.
19 Brookins, Walter R.
58 Brown, Harold H.
Brown, Harry Bingham
267 Brown, Lindop E.
310 Brown, Lawrence W.
185 Brown, Ralph M.
Brown, W. N.
Brownfield, Cris.
283 Brubaker, August J.
Bryant, Frank
208 Bryant, G. M.
Bulask, Herbert
Bullington, Frank A.
Bumbaugh, Capt. G. L.
136 Burgess, W. Starling
Burns, A. C.
212 Burnside, Frank H.
Bush, J. F.
Butler, P. J.
Butterworth, C. H.

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Cabot, Godfrey L.
102 Callan, J. Lansing
Cannon, Jack
Carlstrom, Carl
144 Carlstrom, Victor
Carr, Walter J.
332 Carter, Verne
Cary, C. H., "Bud."
261 Castori, Frank
Cessna, Clyde V.
Chambers, William J.
86 Champion, Frank S.
Childress, E. R.
Christiansen, William
Christmas, Dr. William W.
Christofferson, Harry
Christofferson, Silas
Cline, W. F.
26 Coffyn, Frank T.
Cole, Henry
Cole, Ralph
Coleman, R. F.
Collier, R. J.
160 Colovan, Peter
Cook, Clifton
Cooke, Henry C.
95 Cooke, Weldon B.
60 Cooper, John D.
Coram, B. M.
Costello, A. B.
70 Courturier, Claude
Cowdin, Elliott
Crawford, Harvey
Crewdson, Harry
Crewdson, W. H.
187 Crossley, S. J.
Cribletts, P. L.
239 Crowell, H. K.
35 Cross, W. Redmond
Culiford, P. E.
Cummings, J. A.
Curran, John J.
Curtis, Frazer
Curtis, Greeley S.
1 Curtiss, Glenn H.
Curzon, Joseph W.

D

190 Dalwigk, George B.
Dathan, Wm.
321 Dau, David Davison
Davidson, Howard C.
Davis
Davis, Perry C.
Davis, R. J.
Davison, Frederick Trubee
Day, Charles F.
302 Day, Curtis La Q.
325 Dean, Thomas James
77 De Giers, Clarence A.
129 De Hart, D. C.
de Haussmann, Serge
De Kora, E. L.
72 De Kor, Fred
de Lamos, Raoul Kennedy
38 De Murias, Ferdinand F.
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Kruss, Theodore, Corpl., N. Y. N. G.
Hickman, W. G., License
Moore, Morgan, License.
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Wirthen, 478 Maple Ave., East Orange, N. J.

News of the Fortnight

Aeronautics, We Thank You

The cordial reception which has greeted AVIATION AND AERONAUTICAL ENGINEERING in America has exceeded even our most optimistic expectations. The support which we have received in this country, while we did not anticipate that it would be quite so broadcast or enthusiastic, was not wholly unexpected. We felt confident the aviation enthusiasts in the United States would be glad to read and support a technical paper devoted to the publication of authoritative articles on every phase of aeronautics and aviation. Our confidence has been more than justified. But we did not realize that a hearty reception was also awaiting us abroad. That it was, however, is shown by the following editorial reproduced from the August 30th issue of English *Aeronautics*. We reprint it in all humility and with deep gratitude:

A NEW COLLEAGUE

"-We have never been slow in extending a hearty welcome to any new contemporary, although it may seem a little incongruous that one should extend a hand of friendship to a competitor. But then, competition is good for the soul: it supplies a stimulus to better endeavors lacking to one who is alone in the field. Hence we cordially welcome the first issue of our new American contemporary, *Aviation and Aeronautical Engineering*, which appeared on August 1, and is deserving, if we may take the contents of that number as a fair sample of those we hope may ensue, of a long life of utility. The scope of the paper is well indicated by its title; it makes its bow to the public with the excuse—as if that were needed—that the vast majority of the valuable scientific work accomplished in aerodynamics throughout the world (for the United States, too, are making a belated endeavor—belated since, though the first reliable research work in aerodynamics was conducted by Samuel Pierpoint Langley in the nineties of the last century, and has only been taken up once again this last year—to approach the realm of aeronautical science on strictly scientific lines) remains virtually unknown or so scattered as to be mostly inaccessible. Our new contemporary has, therefore, set out with a laudable, if somewhat ambitious, aim, to collect, coordinate, and publish this information. The greater part of the first issue, which by the way, is excellently produced is taken up by the first instalment of a "Course in Aerodynamics and Aeroplane Design," by Messrs. Klemin and Huff, of the Massachusetts Institute of Technology. Our new contemporary, if it is to attain the high aim it has set itself and to realize its ideal, will have to tread a difficult road, though one infinitely smooth by comparison with the stony mule-tracks negotiated by the pioneers. Looking back on nearly nine years of activity—be it observed that the present constitutes our 150th issue—we are only too glad to extend the hand of friendship to our latest confrère."

The Aero Club of Pennsylvania

The Philadelphia Aeronautical Recreation Society attempted to establish a new time and distance record with a balloon, on September 12. Dr. Thos. Eldridge as pilot and two passengers left the Point Breeze grounds in the balloon "Greater Philadelphia" at 7.02 P. M. After being in the air for twenty hours and fifteen minutes a landing was made near Woonsocket, R. I. When the balloon crossed the Hudson River at Poughkeepsie, N. Y., it was traveling at an altitude of fully 15,000 feet.

On August 19 George Goll and Roy Black, made a flight with E. K. Jacquith from Atlantic City to Cape May, N. J., in thirty minutes' time.

A new hydroaeroplane of the latest type was given its initial tryout at the Philadelphia School of Aviation the latter part of August by Robert Glendinning, president of the school and Clarke Thomson, with the aid and general supervision of Walter E. Johnson, instructor. The climbing and gliding powers were carefully tested.

The delegates to the Inland Waterway Convention who assembled at the League Island Navy Yard on September 15, witnessed a thrilling exhibition by two submarines and a hydroaeroplane. While one of the submarines was submerging and being convoyed by steamer to Chester, a hydroaeroplane from the Philadelphia School of Aviation appeared, flying at about six hundred feet altitude, circling the convoying steamer. It glided to the water's surface alongside the delegates' boat, and accompanied it for several hundred yards. Secretary of the Navy Daniels whose address was interrupted by the arrival of the plane, paused to say that he would never be satisfied until there were ten machines like that attached to every dreadnought, and that as he had never talked against a flying machine he should not do so then.

Tests are being made at the Mineola field of a destructive bomb, the invention of F. E. Barlow, a Philadelphian. It is reported that the experiments up to date have proved successful. The bomb is six feet in length and is formed like a torpedo. In addition to its charge of explosive it contains a gas chamber in which a new combination of gas is used, the exact nature of which is not made public.

The next meeting of the Aero Club of Pennsylvania will be held on Friday evening, October 20.

National Advisory Committee Meeting

The Executive Committee of the National Advisory Committee for Aeronautics held a meeting on September 14 in the new quarters of the committee in the Munsey Building, Washington, D. C.

The subcommittee on the relation of the atmosphere to aeronautics, of which Prof. Charles F. Marvin of the Weather Bureau is chairman, submitted a report on "The Physics of the Air," which will be prepared for publication in the next annual report of the Advisory Committee. This report contains a great deal of data and useful information on meteorology and weather conditions that should prove of practical value to aviators.

A report on aeronautical nomenclature was submitted by a subcommittee charged with its preparation. The committee has received many requests for copies of this report, indicating that the industry is eager to have and adopt standard terms and definitions in place of the many varied and confusing terms that have come into existence with the start and development of aeronautics. This report will be published in bulletin form and issued as a special report at an early date.

The subcommittee on aeronautic instruments is endeavoring to bring about the development of several new and needed instruments for the navigation and operation of aircraft, and at the present time is directly interested in the design of a "ground speed indicator" and an "angle of attack indicator."

A new committee was appointed to consider safe design, construction and navigation of aircraft.

National Research Council Organized

The National Research Council, formed at the request of President Wilson by the National Academy of Sciences to promote the development of applied science in strengthening national defense, held its organizing meeting on September 21 in New York. The purpose is to bring into co-operation existing governmental, educational, industrial and other research organizations.

There was a general discussion of the scope and plan of the council's work. Dr. George E. Hale, director of the Mount Wilson Solar Observatory, in California, was chosen as permanent chairman, and Dr. Cary T. Hutchinson, of the Engineering Foundation, secretary.

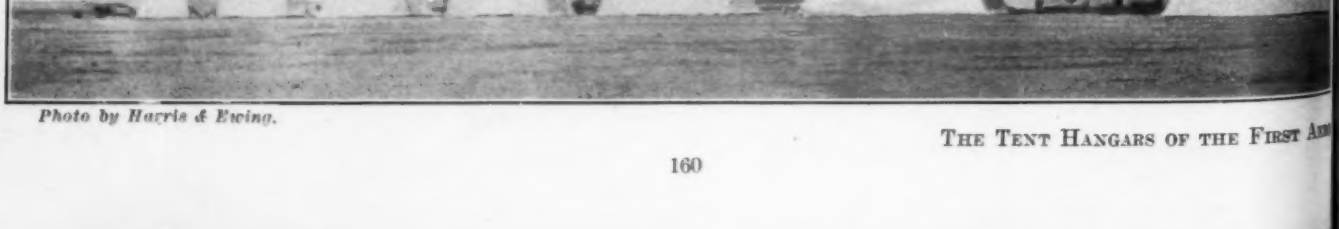


Photo by Harris & Ewing.

THE TENT HANGARS OF THE FIRST AERO

New York Aero Companies Demobilized

Orders have been issued for the demobilization of the First Aero Company, N. G. N. Y., and the disbanding of the Second Aero Company, N. G. N. Y. The Second Company has already disbanded and the officers and men have returned to their homes in Buffalo. It never was mustered into Federal service, it owned no aeroplanes, it received none from New York State, none from the Federal Government. When the National Guard mobilization was ordered by the Secretary of War on June 20, the Second Aero Company was mobilized in its Buffalo Armory. A month later it came to Mineola, L. I., where the First Aero Company was encamped. Here the company stayed, without aeroplanes, till the receipt of the order from the Militia Bureau in Washington, dated September 8, permitting the company to disband.

The First Aero Company is still awaiting orders from the Department of the East in order to carry out the formalities necessary to the mustering out ceremony. The War Department orders have been issued as a result of reports made to the Aviation Section of the Signal Corps, U. S. A., by Captain Bolling of the First and Captain Satterfield of the Second Company, requesting permission to disband.

The First Aero Company's own members largely assisted by the National Aeroplane Fund raised practically all of the money for the company's equipment of four aeroplanes; two machines were supplied by the Federal Government in August. The Federal authorities have undoubtedly profited largely from the experiences of the First Aero Company. The Company has turned out half a dozen fliers who either have taken or are capable of taking their Reserve Military Aviators' certificates. Ten more are now flying alone.

No account of the work of the First Aero Company would be complete without its including a tribute to the commanding officer, Captain Raynal C. Bolling. He has been untiring in working for the comfort and satisfaction of his men. The fact that the constant flights which his men have been making since June 25, have not resulted in a single accident in which one of the members of the company has been injured, is the best proof of the minute and painstaking care with which he has gone about his work. The professional pilots, P. C. Millman and Overton M. Bounds, deserve much credit. With Lieutenant A. B. Thaw they have been entirely responsible for the progress their pupils have made, but without any desire to detract from their services, it is only right to give all credit for such success as the First Aero Company, N. G. N. Y., has enjoyed to Captain R. C. Bolling, R. M. A.

Aerial Border Patrol

"There are now fifteen aerial squads on the Mexican border between San Antonio and Pharr," according to C. J. Trudeau of the United States Aviation Corps, who has just returned from Brownsville, Texas. "Under orders recently issued by General Funston, we have been doing between 22 and 27 miles a day border patrol for the past three weeks.

"The work is mostly for practice, but we have orders to report if we see any Mexicans crossing the river. We carry three or four men in a squad. We are permitted to fly over Mexican territory, but not to alight. Last May I was shot in the hip by a Mexican, but the wound healed up."

Board to Pick Flying Ground

A board of officers, to consist of Lieut.-Col. George O. Squier, Signal Corps; Capt. Richard C. Marshall, Jr., Q. M. C.; Capt. Virginius E. Clark, Signal Corps, and Capt. Thomas D. Milling, Signal Corps, is appointed to meet in New York to investigate suitability of the various military reservations for aviation purposes, or acquire such knowledge as may be necessary.

The Massachusetts Naval Brigade in Camp

The first camp of the Massachusetts Naval Brigade is being held on Misery Island, off Manchester, with a score of aviation students hard at work daily. There are about thirty men and eight officers in the command. The chief instructor for the work is Aviator Clifford L. Webster, instructor for the Burgess Company, and among his pupils are some of the most prominent men in Massachusetts. Included in the number are George R. Fearing, Jr., Godfrey L. Cabot, his brother, Norman Cabot; Gordon Balch, John Balch Blood, who is in command of the camp; Richard Mortimer and Eben S. Draper, son of the late ex-Governor Draper of Massachusetts.

During the first week a total of about 60 flights took place. Four machines have been available for the work; all of them coming from the Burgess Company. Godfrey L. Cabot owns one, and Norman Cabot and George R. Fearing a second. Both are of the Dunne self-balancing type, and require merely to be steered while in the air. A third machine is the Burgess school machine, which has been loaned for the purpose.

A fourth machine is a military type tractor equipped with pontoons, which has just been completed by the Burgess Company expressly for use by the Brigade. It was given to the organization by the Massachusetts Aero Club, which raised the funds for the purpose largely through the instrumentality of Godfrey L. Cabot, president. A fifth machine is to become available early during the present week. This is the seaplane built by the Burgess Company for Eben S. Draper, who is also a member of the militia organization. This is a Dunne type very similar to the machine furnished by the company for the New York Naval Militia.

H. Massac Buist Condemns R. A. F.

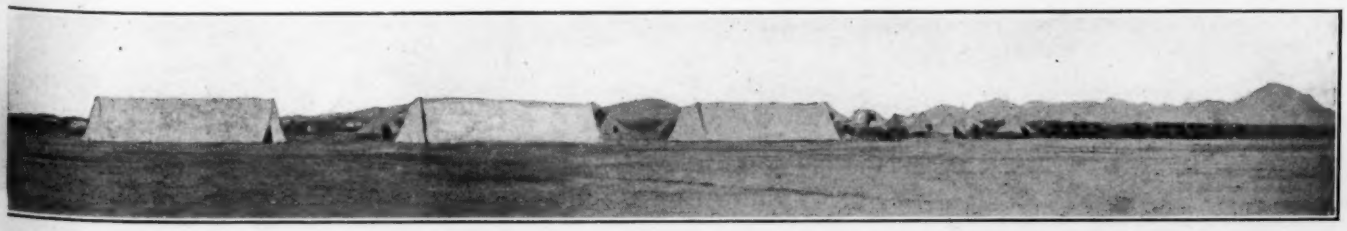
That the British committee's report on the administration and policy of the Royal Aircraft Factory does not condemn severely enough the management of the factory is the conclusion of H. Massac Buist, the English aeronautical expert. In his comments on the recently issued report, he concludes:

"The committee's report fails to touch on a weak spot because the committee do not possess sufficient knowledge to enable them to compare R. A. F. attainment with the best achievement in the world today, and because they have not been able to appreciate that it is no use doing all your experimenting in one place. There are three reasons for this—first, because you cannot monopolize inventive talent; secondly, because designs are worthless unless accompanied by manufacturing experience; and, thirdly, because, though standardization is eminently desirable, in the course of waging a war it is essential to supply the services with more than one type of engine."

Mr. Buist points out that even before the war the Germans had been experimenting with engines of high compression and high piston speeds, rather than the "slow-sloggers" which were reputed to be used exclusively in the German air service, and he blames the R. A. F. severely for imagining that high power and low fuel consumption could be attained only by adhering to slow speed types of motors.

Company B, Signal Corps, Kansas National Guard

This Company, organized by Captain Phil Billard, has been selecting its members with great care and hopes by starting slowly to build up a company of prairie aviators that will be a credit to Kansas. At the present time Capt. Billard's two planes are at the disposal of the members of his command and he hopes to secure by popular subscription sufficient funds to assist him in defraying the expenses of the aviation school which will have to be established. Capt. Billard owns a Curtiss pusher biplane, powered with a Hall-Scott 60 horse-power motor and a special Longren Military Tractor with a Curtiss OX2 90 horse-power motor.



SQUADRON, U. S. A., ON THE MEXICAN BORDER.

Aviation Opinions of the Judge Advocate General

NATIONAL GUARD: Increase of pay for aviation service. The question was presented whether officers and enlisted men of militia organizations brought into the service of the United States are entitled, while on duty requiring them to participate regularly and frequently in aerial flights, to increase of pay for such service, the same as provided by statute for officers and enlisted men of the Regular Army.

Held, that while the Aviation Section of the Signal Corps, provided for in section 16 of the National Defense Act, is prescribed for the Regular Army only, and officers and enlisted men of the National Guard are not eligible for detail to fill places therein, and while there is no corresponding Signal Corps or Aviation Section prescribed for the National Guard, there may be Aviation Squadrons, or unit parts thereof, in the National Guard of the several States as component parts of the "complete higher tactical units" contemplated by section 60, *idem*, and the officers and enlisted men therein will, when duly qualified, be entitled while in the actual service of the United States, or while attending encampments or maneuvers ordered by the Secretary of War, to the same pay and allowances as officers and enlisted men of corresponding grades of the Regular Army receive, including increase of pay while on duty requiring them to participate regularly and frequently in aerial flights. (58-211, J. A. G., August 25, 1916.)

OFFICERS' RESERVE CORPS.

Held further, that the Signal Corps proper and the Aviation Section each constitutes a corps which should form the basis of an organization in the Officers' Reserve Corps, the lowest grade in the Signal Corps being that of first lieutenant. As to the Aviation Section, *held,* that the grade of aviator, provided for in section 13 of the National Defense Act, was created as a means of meeting contingencies and supplying casual deficiencies, and should be regarded as temporary and not as a permanent grade or integral part of the Aviation Section, such as should be made a basis for appointments in the Officers' Reserve Corps, but the lowest grade of the Aviation Section in which an unlimited number of officers may be appointed is that of first lieutenant. (6-301, J. A. G., August 29, 1916.)

Electrical Telethermometers for Aeroplanes

A simple instrument termed an electrical telethermometer, which is likely to be of service, where two motors out of reach of the pilot are employed is briefly described in *l'Aérophile.* This instrument consists of a thin spiral of platinum wire generally placed in the cooling water at the outlet from the motor, connected to a galvanometer, and a small dry battery. The deflections of the galvanometer are a measure of the variation in electrical resistance of the platinum spiral and consequently of the temperature. The galvanometer scale is placed in position to be clearly seen by the pilot. Such an instrument should be valuable as a precaution against overheating, leakage and so forth. The instrument is an adaption of the ordinary type manufactured by Hartmann and Brau, Frankfort-on-Main, Germany.

Navy Airmen Hit Target

That American gunners can hit a target from an aeroplane 2,000 feet in the air almost as well as they can from the deck of a battleship was demonstrated on September 21, when two members of the Aerial Corps from the cruiser *North Carolina* made nine hits out of twelve shots, according to a Norfolk report. The firing was done during stormy weather, the gunners using small arms and bombs.

This is the first experiment of this kind conducted by the Atlantic fleet, and practically every one of the fifty-five ships on the Southern drill grounds took observations.

The targets were surrounded by the entire fleet, while the aeroplanes circled around them at various heights. The highest shooting was from 2,000 feet.

Aeroplane Radio Signals Sent at Night

Captain C. C. Culver, U. S. A., and Lieutenant Herbert Darque are still experimenting with aeroplane radio sets. Recently they have been flying at night at North Island, Calif., for the purpose of transmitting their signals under the conditions which prevail after dark. Flares on the field at the army aerodome are kept burning brightly to indicate to the aviators where they can find their landing place.

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We make everything in rubber for the aeroplane and balloon. Send us your requirements.

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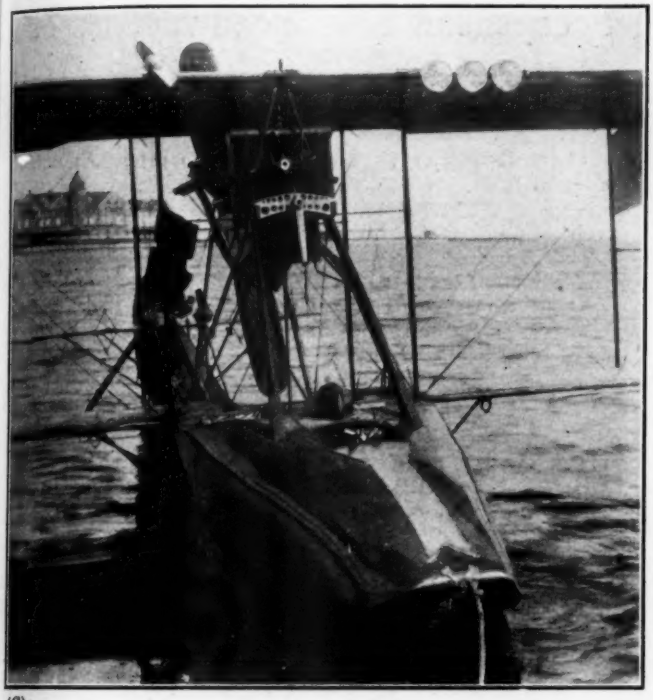
A Sperry Night Flying Equipment

A lighting outfit, in addition to full equipment of automatic control devices, is the latest safety appliance produced by the Perry Gyroscope Company. Three 50 candlepower searchlights are attached to a fitting on the upper entering edge of the biplane which Lawrence Sperry has been using in night flying experiments at Amityville, L. I., for the past few weeks.

The searchlights are mounted in parabolic reflectors which, it is claimed, increase the candlepower to 40,000 for each lamp. The fitting, which secures the lamps to the upper plane, is designed so that it can be tilted in the vertical plane by turning a knob, which is placed within easy reach of the pilot's hands.



(C)

SPERRY NIGHT FLYING EQUIPMENT.

This device makes signaling with the searchlights a possibility, as well as focusing them on any given point, when the pilot is ready to make his landing. The Morse code can also be used with these searchlights, as the lights themselves are controlled by a switch normally held open by a spring, which can be operated like a telegraph key.

The electric current is supplied by a generator of 150-watt capacity, which is driven by the air pressure at, approximately, 4,000 revolutions per minute. Provision is made for any accident to the generator by means of a storage battery, which in case of trouble is automatically thrown into the circuit.

The machine Mr. Sperry has been using is also equipped with the Sperry automatic pilot and synchronized drift indicator. A Sperry air compass, protected by a waterproof hood, is also part of the equipment.

IT IS REPORTED THAT—

ORVAR MEYERHOFFER, the well known aviator of San Diego, has made a record during the summer that is most interesting. On one day he made forty-two flights. His regular average is from six to twenty trips a day. He tells a good "fish story" which runs as follows: "I have used my hydroaeroplane in deep sea tuna fishing a number of times. By flying at an altitude of 500 feet over the sea the location of the fish can easily be detected. I then volplane to the kelp beds, where the water is invariably smooth, land and then skim out to where we sighted the fish. Dropping overboard a boathook to keep the plane from drifting, we get out our rod and reel and the sport of hooking the wily tuna is on."

E. K. JAQUITH, who has been flying at Atlantic City for the last three years, is planning to open an aviation school at St. Augustine for the winter.

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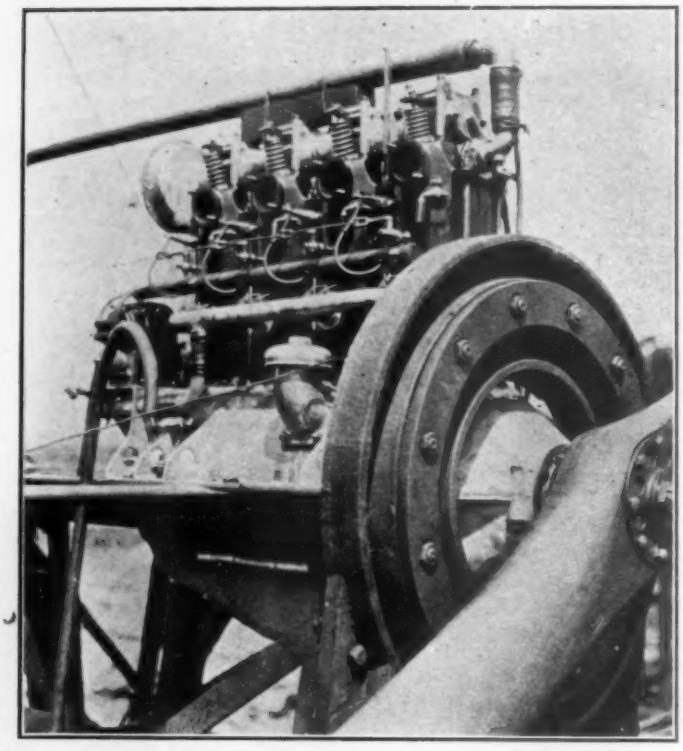
The Hall-Scott Type A-7 Power Plant upon Torque Stand, at the factory, where all statistics are carefully taken by a representative of Robert W. Hunt & Co., engineers. Hall-Scott Motor Car Company, Inc., states that its engineers and mechanics do not make out performance cards upon motors.



Hall-Scott Co. Busy on Government Orders

The Hall-Scott Company is manufacturing eight "Big Sixes" a week, as well as two of their fours. An order of over 300 of the sixes is being filled as rapidly as possible. The Dutch East Indies Government has placed an order for twelve of the "Big Sixes" and eight small fours. The Netherlands have purchased eight of the large motors and is arranging for a much larger order when these are delivered. Three other European governments are using Hall-Scott equipment. The United States Navy has purchased twelve "Big Sixes," and the Army twenty-two. Besides this government business, the Hall-Scott Company is supplying motors to the following companies: The Standard Aero Corporation, L. W. F., Pacific Aero Products Company, M. F. P., and the Glenn L. Martin Company.

IT IS REPORTED THAT—

ADJUTANT GENERAL FRANK L. BRIDGES of Indiana is the first State official to try to take advantage of the provisions of the National Defense Act of June 3 to form an aviation corps for the National Guard of his State. He has written to the Indiana troops at Llano Grande, Tex., for applicants who desire to take the six months' course in aviation at the San Diego, Cal., Army School, which the War Department will give to eligible officers from every State.

TRUBEE DAVISON, son of H. P. Davison of J. P. Morgan & Co., has ordered a new Curtiss flying boat of 90 horse power similar to those he has been learning to fly during the past summer.

FIRST LIEUT. HAROLD S. MARTIN, aviation officer, Signal Corps, was relieved from duty at the Signal Corps station, Mineola, L. I., N. Y., by an order issued September 11, and sent to Boston, Mass., for the purpose of taking a post-graduate course in aeronautical engineering at the Massachusetts Institute of Technology.

THE QUEEN CITY AERO CLUB of Cincinnati is building a monoplane with 30 feet wing spread, 26 fore and aft, chord 6 feet 10 inches, cambre 3 inches. It will be provided with a 30 horse power air-cooled "Premier" long stroke motor and used for school work among the members as a "penguin."

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All students are permitted to attend factory daily or three evenings a week to receive training in aeroplane design and construction and to become familiar with gasoline motors, in order to become competent aviators.

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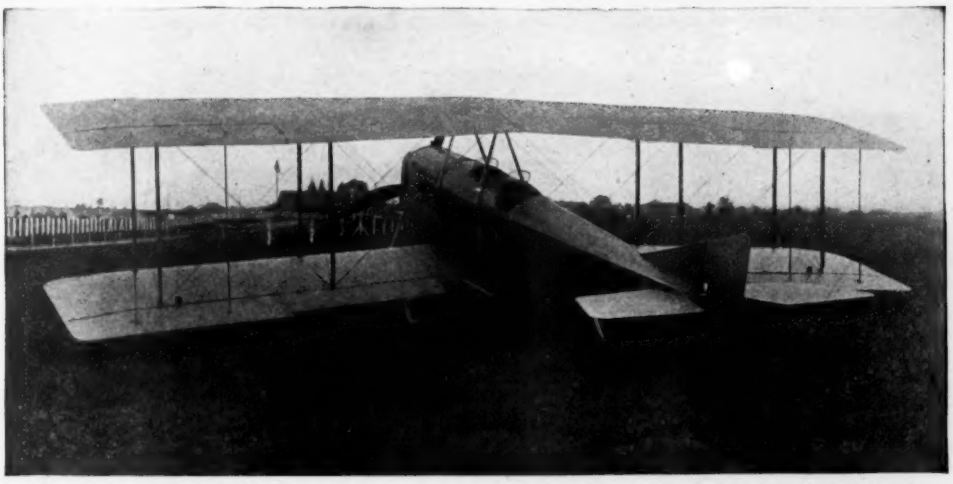

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J. E. PORTER, of Waco, Texas, candidate for Congressman-at-large, spent, according to his sworn statement, 3,200 in operating an aeroplane in which he did a large amount of canvassing in his campaign for the nomination at the recent State primary.

EDWARD HUBBARD rescued a couple from drowning in Lake Washington near Seattle, Wash., a few days ago. S. E. Kerney and Miss Vera Collins were watching his flying boat from a canoe. The canoe upset. Hubbard volplaned to the water and took them both aboard his craft where they awaited a boat from shore.

O. TIMM, the aviator is filling engagements at county fairs in the Middle West. On September 22 and 23 he flew at the Richland, Mont., County Fair.

TESTS of the new Navy hydroaeroplane N-9 were satisfactory. Newspaper reports say that she made 69 miles an hour, high speed, and 41 miles an hour low speed.

MISS RUTH LAW is giving exhibitions in Nebraska.

WILLIAM EARL DODGE will establish a training school of aviation and national defense at Jacksonville, Fla. He intends to train there sixteen college graduates under twenty-five years of age, who will begin to learn to fly November 1. Frederick C. Eden will have charge of the training of the pupils.

JACK MILLER died on September 13 at Fredricksburg, Tex., as a result of injuries received when he fell with his aeroplane while giving an exhibition at the Gillespie County Fair on that day.

TWENTY-SIX Mexicans are attending the flying school established by the Carranza government just outside Mexico City.

ART SMITH, the 22-year-old aviator, who has thrilled Chicago, San Francisco and Japan, may never fly in public again. He may go to Japan to become interested in a $5,000,000 plant for the manufacture of aeroplanes.

THE AEROMARINE PLANE AND MOTOR COMPANY has a 300 horse-power Sprague dynemometer installed at its plant at Nutley, N. J., and can run tests on any size motor up to 300 horse power.

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LICENSED AVIATOR wants position. Best references. Will do exhibition work, passenger carrying or instructor. Individual or Company considered. Address Box 4.

FOR SALE—Single passenger training biplane, equipped with 3 cylinder 35 H. P. Anzani motor. Motor and plane both brand new. Ideal equipment for beginner to use as penguin or for short flights. Can be seen at U. S. Army aviation field at Mineola. Property of 1st Aero Company. U. S. Government desiring to standardize equipment for school work did not take over this plane, which is in perfect condition. Address Box 5.

GRADUATE ENGINEER; experienced on several leading American aeroplanes; good calculator, designer and systematizer. Can take charge of work. Available now. Address Box 16.

TECHNICAL GRADUATE, age thirty, desires position in experimental department of aeroplane company. Has had five years' experience on special development work, manufacturing and advertising. Address Box 36.

AEROPLANE DESIGNER desires position at designing and construction. Capable to superintend the entire development and building of machines. Has had four years' practical experience. Address Box 48.

YOUNG MAN DESIRES POSITION with Aeroplane Company, to learn aviation and secure opportunity of becoming tester and salesman. Address Box 2.

POSITION open as instructor in Flying School for expert pilot who has some knowledge of the theory of aeronautics. Box 12.

WANTED. Experienced man for advertising purposes mostly publicity work. Aeronautical knowledge, especially dirigible air craft, desirable. References required. Address Box 7.

WANTED. A graduate technical engineer to head an experimental department under experienced aeroplane designer. Box 22.

WANTED. Head draughtsman for draughting room, a man who understands and can install system. Box 23.

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